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WITH SELF-LUBRICATING BEARINGS

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The Bearings of the Hoist have GRAPHITE BRONZE BUSHINGS. They are self-lubricating, they require no oil, and will run indefinitely without cutting.

These hoists will raise a load of two tons to a height of one foot with a pull of 125 lbs. while overhauling only 39½ feet of hand chain.

As you would have to overhaul at least 90 feet of hand chain to do the same work on the best Screw Hoists, it is plain that the CYCLONE is more than twice as fast. It can be geared to a higher speed than any other hoist with no greater hand wheel pull. **There is the least possible friction loss, the efficiency averaging nearly 80 per cent.**

When there is no load the hand wheel may be spun in either direction.

When the hand chain is released the **Automatic Brake** immediately locks the block so that the load is safely held at any point. It may be readily lowered, however, by a reverse pull on the hand chain.

WE WILL ACCEPT FIRST ORDERS SUBJECT TO APPROVAL AFTER TEN DAYS TRIAL

Send for Catalog Illustrating Full Line of Hoists and Trolleys

20 Tons

Having Two Hand Wheels and Two Speeds

Manufactured by

The Chisholm & Moore Mfg. Co.

Cleveland, Ohio, U. S. A.

Dry or Wet — Which?

If Dry —

Use Kantbebeat Dry Core Compound — the standard of the country.

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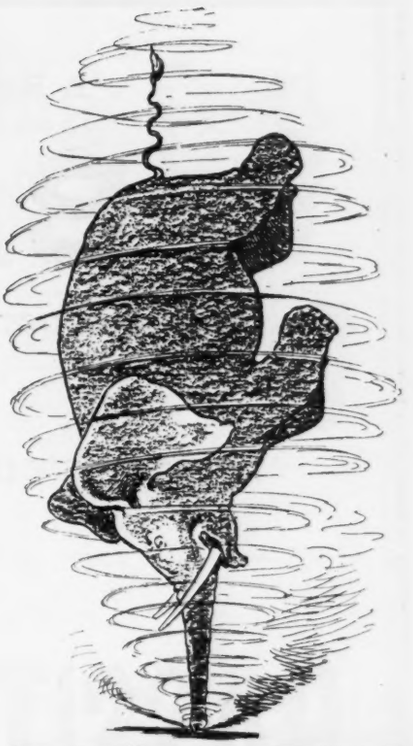
Use "Esso" Liquid Core Binder. Our own make — that's a guarantee.

Both are cheaper than flour, rosin, or any other core mixture.

The S. Obermayer Co.

Cincinnati **Chicago** **Pittsburg**

You have seen nothing like it



There are all kinds of wet blackings but there is nothing in the market like **Stevens' Carbon Blacking.**

The reason is simple.

The same basic materials are not used in any other blackings.

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If eight or ten representative foundrymen called at your office today and told you that, from their own experience, my statement was the truth and nothing else, you would order a barrel. Would you not?

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Connellsville Foundry Coke

There are good, honest people who sell coke "just as good" as Connellsville; but they don't know the needs of a Foundry. They don't know that one car of high sulphurous coke means a lot of trouble. Buy your coke of me and be assured of good quality. I know the coke business.

The price is now so low, you can afford to buy whether you need it or not.

Still Another

I manufacture **Buffing Compositions** and **Platers' Supplies,** and every Foundry running a Polishing and Plating Plant can learn something to advantage by taking up the subject with me.

Write for catalog "F"

Frederic B. Stevens

Cor. Larned and Third Sts.
DETROIT, MICH.

See page 113

A Revelation in Brass Foundry Methods.

BASSITE

A NEW PRODUCT THAT IS A PERFECT SUBSTITUTE FOR TIN IN BRASS CASTINGS.

Some reasons why every Brass Foundryman should use Bassite:

BASSITE

I. Will save from 40 to 45 % on your tin bill.

II. Will save from 10 to 30 % in finishing your castings.

III. Will practically eliminate porosity in your castings.

IV. Makes a much denser and tougher casting than tin, and is practically non-crystallizable.

CASTINGS

I. Containing Bassite can be finished at from 65 to 80 % the cost of castings containing tin, because they will take the tool freely, cutting very easily.

II. Containing Bassite will take a much finer polish than any other brass casting.

This product is especially adapted to Steam Goods, Machinery and Automobile Brass Castings.

Let us give you proof of the above assertions, and ship you a trial order of 100 pounds.

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Bassite Mining & Smelting Co.

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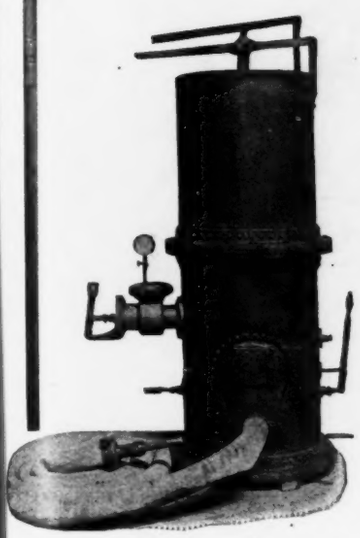

Reduce Cleaning Costs

By Adopting Present Day Methods

You can cut expensive labor by more than half—clean castings of brass, iron or steel quicker and better, and constantly add to your profits by producing satin finished castings at rock-bottom prices, with the Tilghman-Brooksbank Sand Blast Machinery.

Our PATENT EXHAUST SYSTEM
is in connection with the above

Will you accord us an interview?

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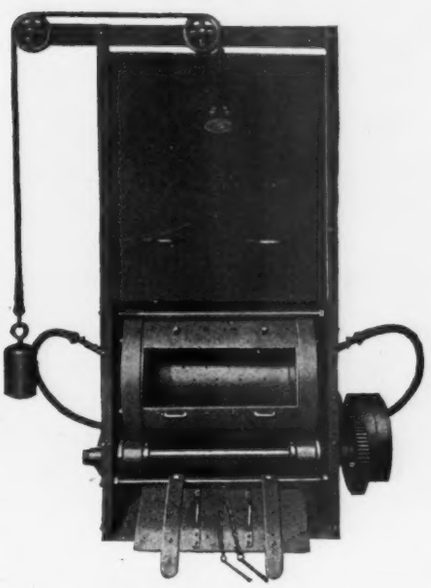
For the rapid and thorough cleaning of small castings. Preserves the sharpness of outline and materially lessens breakage of castings of fragile form.



Write for illustrated Circulars, which fully describe these machines.

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A new device that is most economical and convenient for rapid drying of moulds. Simple in construction and operation. Can be easily handled by two men and quickly moved to any part of the foundry. The drier can always be kept ready for instant use.

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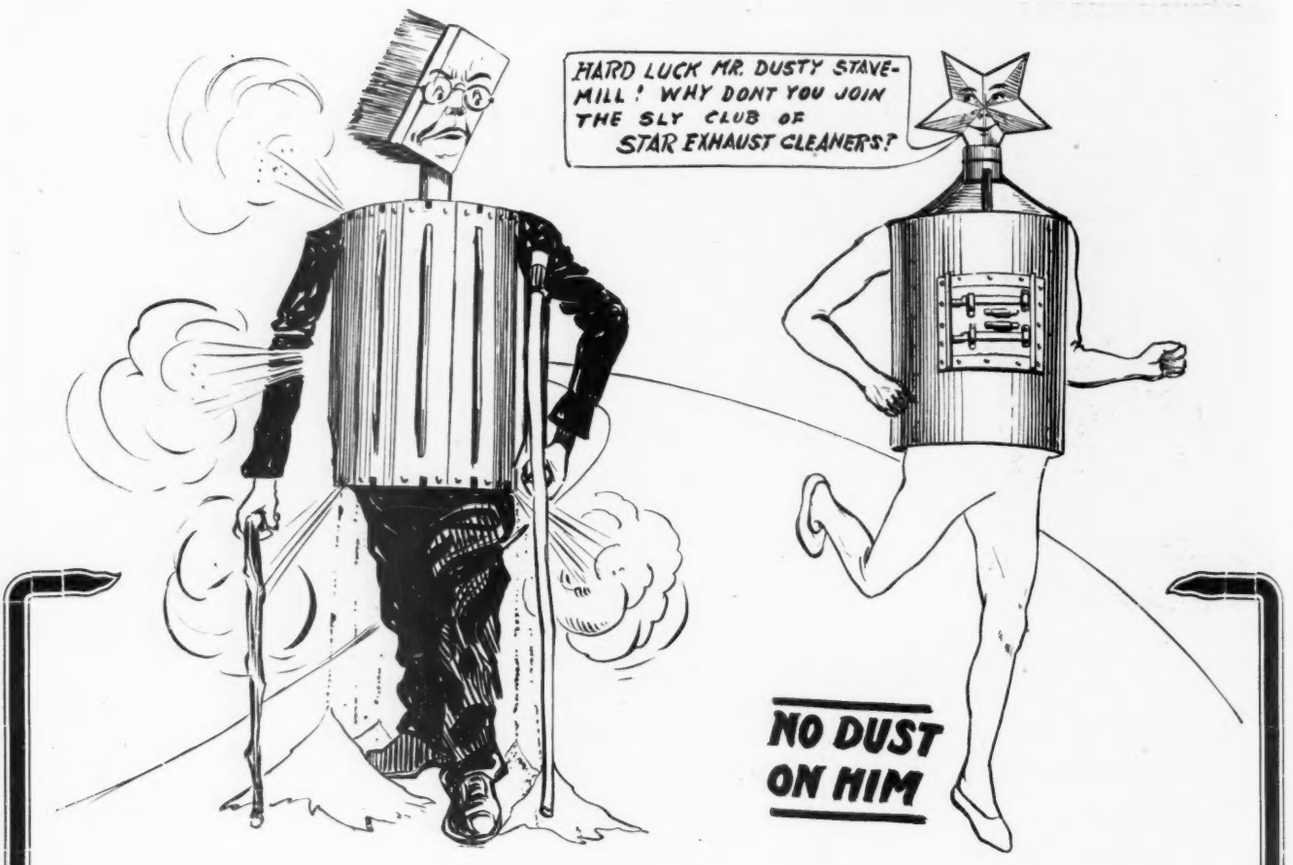

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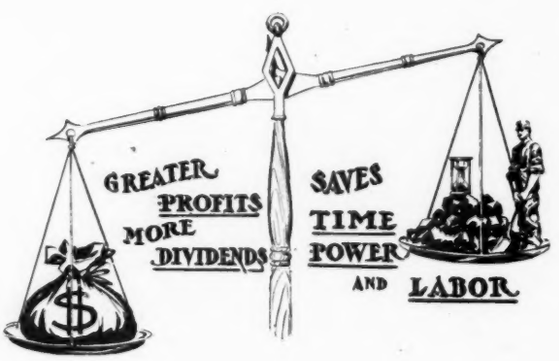

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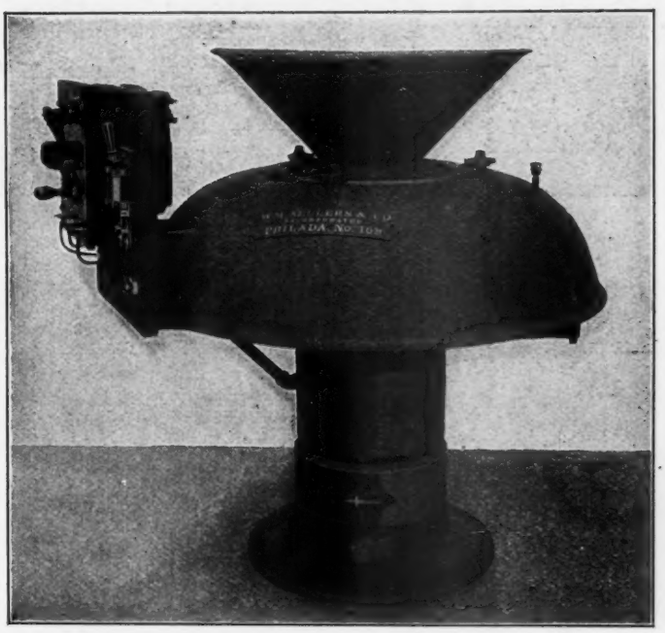

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Thoroughly, evenly and quickly mixes all kinds of molding sand, core sand, foundry mixtures, etc., and at considerable saving in cost over other methods.

TRAVELING CRANES, JIB CRANES,
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Schwartz Melting and Refining FURNACE

In sizes from 100 lbs. per heat to 10,000 lbs. Capacity.
The Pioneer in Brass and Copper melting furnaces. The most Economical and Durable.

The Ohio Brass Co.

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"Sold on guaranteed results"

Write for new catalogue.

The Hawley Down Draft Furnace Co.

CHICAGO U. S. A. NEW YORK

LOOK UP! CHEER UP!! SMILE!!!

Well! Things certainly am a humming. Stock taken for 1907, profit on the right side—and now, say, honest, 1907 wasn't so bad. **Laugh!** But those two last months were fierce. The great American public wants too much. A fortune in a minute. Not much; it takes a lifetime. Go **slow** but **sure,** but be **modern** in the **"Brass and Steel"** Foundry. Arrange for sufficient melting capacity for this **"Spring's"** business. Remember your promises to install our equipment, operating with "Fuel Oil or Gas," and save **"50%."**

WE MANUFACTURE

The "Steele-Harvey"
CRUCIBLE METAL MELTING FURNACE

Monarch Removable Crucible Furnaces
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We will contract to equip your foundry with sufficient furnaces, guarantee satisfactory prices, quick shipments, instructions without charge, and terms of payment **as agreeable to you.**
All demonstrations subject to approval.
Furnaces up to 1,500 lbs. capacity per heat.

Let us mail you our "1908" Catalogue.

The Monarch Engineering & Mfg. Co.

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It Was The Year 1892

There had never been a publication, of any kind, devoted to the interests of the foundry business and, as far as we know, there had never been any discussion as to the advisability of such a publication.

About this time, a certain iron molder, without any previous newspaper experience or knowledge of the publishing business, consulted a number of his friends, with reference to the desirability of a magazine of that character and the possibility of its being a success and found that they were a unit in declaring there was no room for anything of that kind and that it could not possibly succeed.

This did not, however, deter him, but rather inspired him to endeavor to convince them that they were all wrong. As a result, in September, 1892, the first issue of "THE FOUNDRY" appeared and it has been appearing ever since—and never missed a month.

It was, at the beginning, a little 32-page, magazine size affair, but since that date it has grown some. The number of reading pages have grown from 20 to 50 and its advertising pages have increased from the first issue until we now print regularly more than 100 pages each issue.

In addition to the foregoing, we lately practically doubled the size of its pages, so that we are now giving about five times as much reading matter as appeared at the beginning, and all this without ever having increased the subscription price of $1.00 per annum.

And yet, in those days, after the first number appeared, there was joy and unlimited enthusiasm all over the land, among the leading foundrymen everywhere, because they, at last, had a publication devoted to their interests.

It was not much at first, but it promised big things later. And it became better right along from the first number, until now it is the best edited, most handsomely illustrated monthly trade journal on earth, and has more enthusiastic friends than any other we ever heard of.

But that is only a small part of the story.

"THE FOUNDRY" publishes better, more up-to-date and a greater amount of first-class foundry literature than all the other trade journals in this or any other country combined.

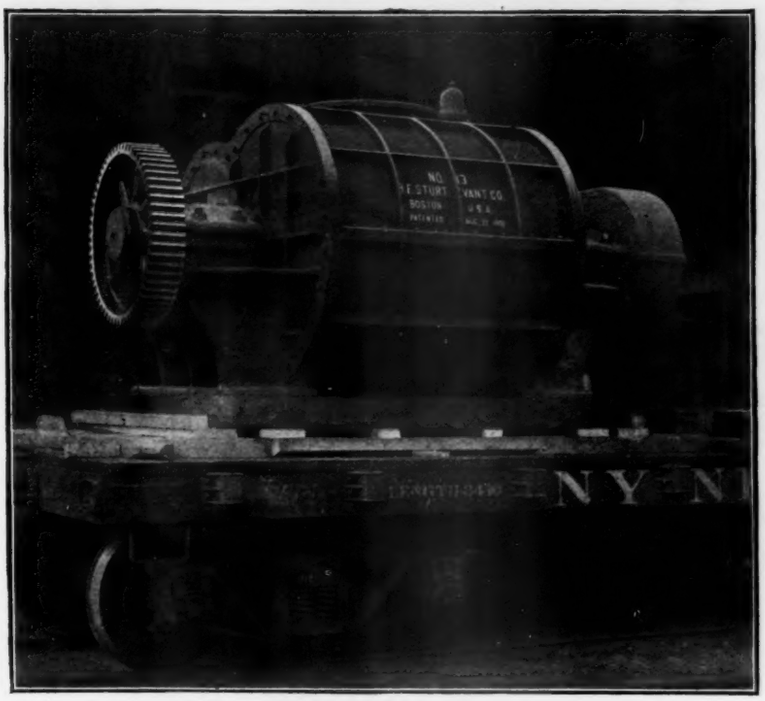
It has more foundry readers and carries more foundry advertising than all the others put together and the advertisers get better returns from it than from all the others.

It goes all over the world and in every country where a cupola can be found there will also be "THE FOUNDRY," carrying the gospel of modern, thoroughly up-to-date foundry practice, and its list of subscribers and advertisers is still on the increase, the same now as fifteen years ago and, in all probability, it will be growing at a similar ratio fifteen years hence.

Here's hoping we may all live to see it in 1923.

THERE IS
ALWAYS ONE STANDARD

BY WHICH THE REST ARE MEASURED



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For Whitin Machine Works, Whitinsville, Mass.

In the blower world the

Sturtevant High Pressure Blower

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THE ROTORS ARE ABSOLUTELY INDEPENDENT OF EACH OTHER

Send for Bulletin No. 152.

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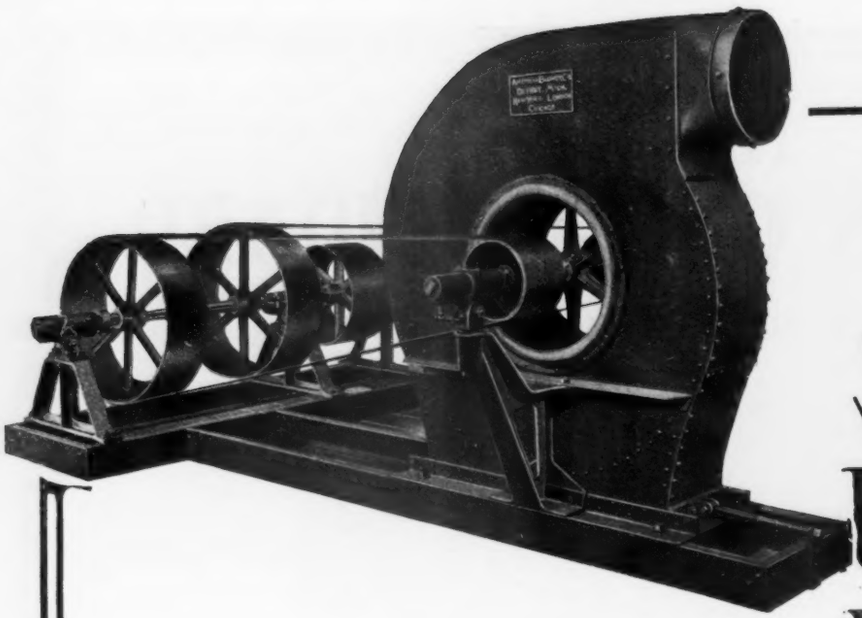

A Steady Uniform Pressure

of 20 oz. to the square inch, is readily and economically maintained by the

Type P "ABC" Steel Pressure Blower

For foundry work, the "ABC" is unexcelled. It gives a steady, even, sustained blast, the cost is a fraction of that of a rotary blower and the service more satisfactory.

The "ABC" Type P Blower consumes but a fraction of the power a rotary blower of equal capacity requires.

Altogether, it is a much more desirable apparatus, as it costs less in the first place, is less expensive to operate, easier to manage, more durable and gives better results.

We have these Blowers of all sizes, top or bottom discharge, and with or without bed.

Send for our Catalog No. 190F which fully explains how you can get the most efficient blower for the least money.

AMERICAN BLOWER CO.

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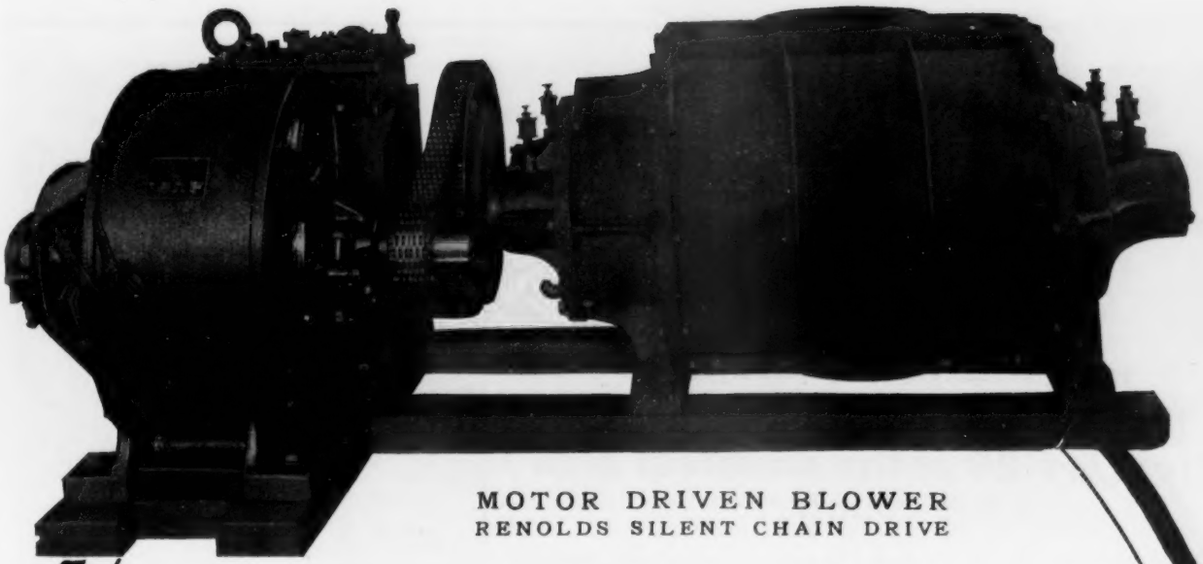
NEW YORK CHICAGO ATLANTA LONDON



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RENOLDS SILENT CHAIN DRIVE

THE OLD RELIABLE

GREEN ROTARY POSITIVE PRESSURE BLOWER

is earning money for others. Why not also for you? Said a General Superintendent of one of the largest iron works in the United States, after recently installing one of our No. 6 A blowers:

"It reduced the time in running our heat the first day, one hour."

Wilbraham-Green Blower Company

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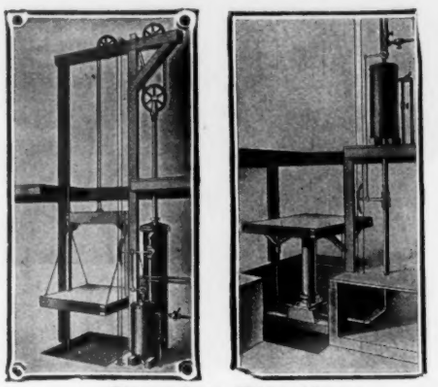
1854 **1908**

Talk About Hard Times!

Here is a list of some of those who are getting Steam Hydraulic Elevators and installing them Right Now. You will note Mr. Foundryman is there with the rest. If we used this whole paper we could not present more overwhelming evidence of the popularity of the Steam Hydraulic than this list of "Hard Times" customers.

Here are 26 of the smartest men in the country.

They are getting ready for the good time coming when the old pendulum swings back.



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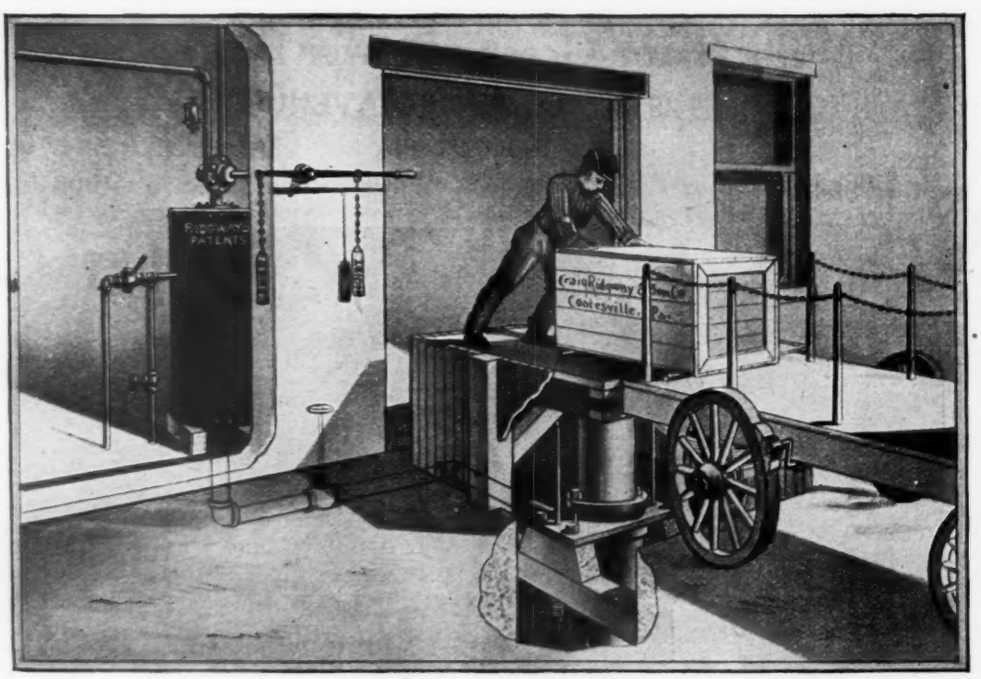
If you are a real smart Foundryman you too will take this opportunity to

Hook'er to the Biler

CRAIG RIDGWAY & SON COMPANY

Coatesville, Pa.



Greatest Modern Money Saver

THE FOUNDRY

Vol. 32, No. 1 CLEVELAND, OHIO, MARCH, 1908 Whole No. 187

SILICON-COPPER IN THE BRASS FOUNDRY

A Comprehensive Discussion of the Properties and Use of This Valuable Alloy—Mixtures

BY C. VICKERS

SILICON-copper is a dense, non-crystalline silvery white alloy. It is sold in ingots weighing about 14 pounds each. The metal is so brittle that the thick ingot can be easily broken with a light tap of a hammer. When broken, it does not crumble like antimony, but splinters like glass. These splinters are sharp and will cut; therefore, it is not advisable to break the metal while it is held in the hand, although this can be done.

The freshly fractured surfaces of silicon-copper, at first silvery, assume a reddish tint when exposed to the air. The content of silicon is from 20 to 30 per cent, and this alloy is the most convenient means of using silicon in the brass foundry, as this element, when in a state of purity, possesses none of the characteristics of the metals used in foundry practice. It occurs in three froms like carbon to which it is closely allied.

Forms of Silicon.

These different forms of silicon have been designated as amorphous, diamond-like and graphitoidal.

The amorphous variety is a brown powder and melts and becomes liquid at a little under the melting point of cast iron. This brown powder can be changed into graphitoidal silicon, by heating with common salt. This variety of silicon very much resembles true graphite and exposure to high temperatures changes it to the diamond-like variety of silicon which bears a greater resemblance to a metal than any of the varieties.

It will be seen, therefore, that, owing to its non-metallic appearance, silicon in foundry practice is always used in the form of a rich alloy with some other metal as copper or iron. For the use of the brass founder, silicon must be in alloy with copper, while the iron founder uses ferro-silicon.

Historical.

Regarding the early history of silicon copper, the following particulars were furnished the writer by Alfred H. Cowles, the inventor of the electric furnace. He says:

"The addition of silicon to copper, for improving the same, had been recommended in Europe prior to 1885. In the latter part of 1884, or early in 1885, working with my brother, Eugene Cowles, we succeeded in reducing sand or silica, directly by the use of carbon alone, in the electric furnace we invented.

"We also reduced many of the other rare elements, and shortly thereafter began to manufacture the silicon-copper that is now on the market. Its de-oxidizing value, in removing copper oxide, dissolved in molten copper, had not been pointed out in the early literature. An alloy of copper, with about 1 per cent silicon, had been recommended as giving strong wires for telephone conductors, see *Electrical Review*, February, 1885.

"The silicon here used had been produced by old chemical methods.

"The first description published of the electrical furnace method was before the Aug. 28, 1885, meeting of the American Association for the Advancement of Science, by Prof. Chas. Mabery, my brother and myself. Another paper was published that was read by Prof. T. Storey Hunt before the Sept. 10, 1885, meeting of the American Institute of Mining Engineers at Halifax, N. S."

Mr. Cowles organized the Cowles Electric Smelting & Aluminum Co., and built works at Lockport, N. Y., in 1886, where were made alloys of copper with silicon and aluminum, and where aluminum was produced in ingot and other forms by means of the electric furnace.

Use of Silicon in the Brass Foundry.

The principal use of silicon in brass foundry practice is to produce solid copper castings. Previous to its introduction it was impossible to cast copper.

Copper castings, so called, were, of course, made, but they were really alloys of copper with zinc, or zinc and tin, and sometimes phosphorus. All of these de-oxidizing agents greatly reduced the conductivity of the copper castings. Consequently, where high electric efficiency is required, such castings are unsatisfactory. It is a curious fact that electricity, which has caused the demand for castings of pure copper, has made such castings possible by creating the high temperatures necessary for the reduction of those elements whose affinity for oxygen, makes them so valuable in removing that impurity from the melted copper.

As we have seen, it is some 20 years since silicon copper first became a com-

Editor's Note.—The first prize was divided between C. Vickers and A. C. Hemist, this article being awarded one-half the first prize, in the contest conducted by THE FOUNDRY.

mercial possibility. It is not, however, as well known to brass foundry practice as it deserves to be.

Elimination of Blow Holes.

There are many brass founders who have never used it, others again who have used it, do not know how small a quantity will eliminate blow holes.

To determine this point the following experiments were made: No. 1—Scrap copper (trolley wire) 25 pounds; silicon-copper, four ounces.

The castings were perfectly solid, the metal being easy to cast in sand.

No. 2—Copper, 25 pounds; silicon-copper, three ounces.

These castings were solid.

No. 3—Copper, 25 pounds; silicon-copper, two ounces.

Castings solid.

No. 4—Copper, 25 pounds; silicon-copper, one ounce.

The castings were still solid, but the head sank down. The metal did not cast as well, as when more silicon was used.

No. 5—Copper, 25 pounds; silicon-copper, ½ ounce.

The sprue head swelled slightly, and the castings showed pin holes. The quantity of silicon was insufficient.

In the sixth experiment, 15 pounds of copper were melted and ½ ounce of silicon-copper was added. The castings were solid; the head shrunk as usual, although there was a tendency to show a few pin holes on the cope side of the casting. This represents the minimum amount of silicon that can be used to produce solid castings. This experiment was interesting in that it proved that ¼ of 1 per cent of silicon-copper is sufficient to de-oxidize brass or bronze.

In all these experiments the silicon-copper was added to the molten copper, and the metal superheated five minutes before pouring. Every precaution was taken in melting. The metal at all times was covered with charcoal, as experience has proven that copper containing even 2 per cent of silicon-copper is capable of producing spongy castings, when carelessly melted.

Remelting Scrap.

Copper gates and other scrap which has been de-oxidized with 1 per cent silicon-copper, can be remelted several times without further addition of silicon, and give solid castings, provided proper precautions are taken in melting.

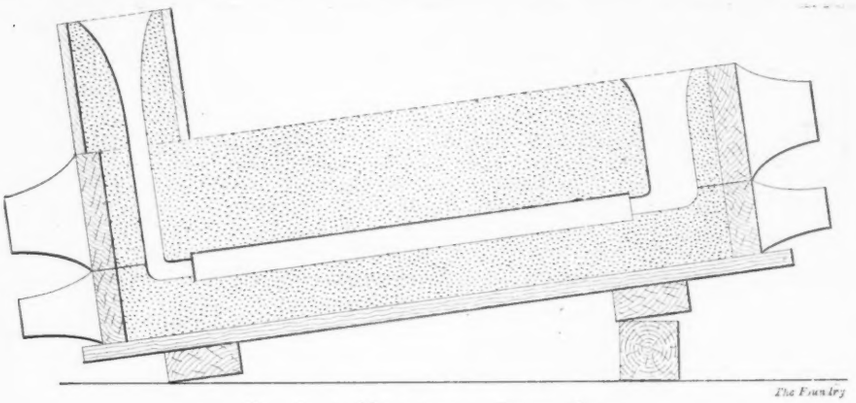


FIG. 1—A MOLD FOR A COPPER SLAB

Hardening Effect of Silicon.

In order to determine the effect of silicon in hardening copper, we melted copper, 10 pounds and silicon-copper, one pound. There was no such hardening effect as would be with the same amount of tin. The castings had every appearance of pure copper; they were soft, fracture inclined to fibrous, and the color internally was a little lighter than pure copper.

Silicon, therefore, does not harden copper like tin, neither does it change the color like zinc. Five per cent of zinc will change the red color of copper and incline it to yellow. One-fourth of 1 per cent of silicon-copper will restore the copper color to the castings externally, giving them the appearance of copper.

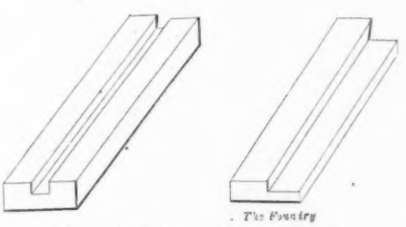


FIG. 2—COPPER FUSE BARS

Effect of Silicon on High Phosphorus Copper.

Copper, so rich in phosphorus that it will cut into the sand of the mold, making rough castings, can be deprived of such undesirable qualities, by the addition of silicon (½ of 1 per cent of silicon-copper).

Strength of Copper.

To determine the strength of copper, the following alloys were cast and tested:

No. 1—Copper, 100 pounds; silicon-copper, one pound.

The tensile strength was 23,000 pounds per square inch.

No. 2—Copper, 100 pounds; silicon-copper, eight ounces; tin, 1¼ pounds; zinc, 1¼ pounds.

The tensile strength was increased 26,000 pounds per square inch.

No. 3—Copper, 100 pounds; zinc, six pounds.

Tensile strength 24,000 pounds per square inch.

No. 4—Copper, 100 pounds; phosphorus, 1½ pounds.

Tensile strength 17,800 pounds per square inch.

None of these alloys were remarkable for strength, though possibly better results might have been obtained by the use of ingot copper in place of the scrap trolley wire that was used.

No. 4 was very low, showing it contained too much phosphorus. It was made purposely very hard, being a copper used for special work. All these test bars were cast without any special precautions in the way of securing castings free from flaws, the idea being to find out what could be expected in the way of tensile strength from castings made in the ordinary manner by the ordinary molder, and as such they are fairly representative.

Bronze Test Bar.

A bronze test bar cast at the same time, in the same manner, for purposes of comparison, possessed a tensile strength of 35,000 pounds per square inch, which proved to our satisfaction that the copper bars were as good as could be expected without the exercise of greater care in the selection of the metals, and in molding.

Molding.

Silicon has much the same action on copper as aluminum. It makes dross and scum, and causes the metal to shrink abnormally. This shrinkage can be controlled by risers or feeders suitably placed on heavy castings. To avoid dross the castings should in all cases be gated at the lowest point, preferably with a horn gate. To prevent scum the metal must enter the mold quietly without agitation. It is best, therefore, for it to enter by one gate only. Should there be two or more gates, the various streams of metal are liable to impinge against each other, producing agitation of the metal and consequent scum in the casting.

Many copper castings take the form of slabs. To illustrate the method of gating we will imagine we have such a

slab to make and we will suppose it is 2 feet long, 6 inches wide and 1 inch thick.

The casting must be poured from the "bottom up" with any copper containing silicon or aluminum; but a flat slab has no "bottom" in the sense that a deep casting has. We, therefore, overcome this difficulty by inclining the mold and gating at the lowest end. The metal must then climb a hill and does this slowly and gradually without any agitation, thus producing a smooth, clean casting.

Fig. 1 shows a section of the mold through sprue and feeders. It will be seen that the pouring head is built up to obtain pressure sufficient to force the metal up the hill and fill up the feeder. This feeder is placed on the highest point of the casting, and should be generous in dimensions. In this case the casting being only 1 inch thick, a three-inch feeder would probably be sufficient to hold it up; but if the casting were 2 or more inches thick, or had heavy sections in it, a much heavier feeder would be required. The gate connection between feeder and casting should be large enough to give the casting the benefit of the mass of metal in the same, so that it will remain open and permit of the fluid metal in the feeder to seep back to the casting to make good the shrinkage.

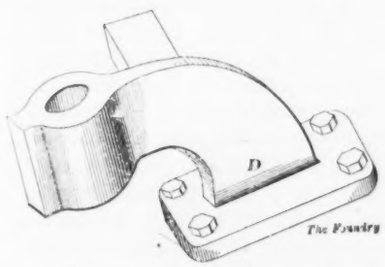


FIG. 4—COPPER CASTING

Effect of Small Feeders.

If the feeder is too small, the casting will be "shrunk;" that is, there will be hollow places or depressions on top of the heavy sections. Sometimes it may seem difficult to prevent this, but it can be done by a proper disposition of risers or feeders, and by making them sufficiently large.

Casting Small Sections.

The method of running the metal up hill is good for floor work as stated, but in the case of smaller castings it is not always feasible, to build up the head to force the metal up the hill, neither is it always necessary to have risers at the other end.

In the case of such castings as fuse bars, which are copper castings with grooves or slots running lengthwise as in Fig. 2, they can generally be made in the usual brass molder's standard flask, 12 x 18 inches, and become incomparably better when the metal is run up hill.

To accomplish this, a long runner is rammed up between the two patterns in the nowel, the sprue is placed on this runner at the highest end of the mold—the end that is tilted up—and the gates are cut from the runner to the castings at the lowest end—the opposite end from the sprue—so the metal is carried by the runner to the bottom of the mold, where it enters the castings, gradually rising up hill.

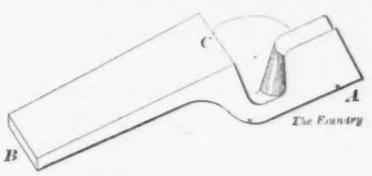


FIG. 3—COPPER CASTING

Shrinkage.

To control shrinkage a heavy shrink ball is placed in the cope on top of the runner where the gates are connected. Without this shrink ball there would be a hole when the gate is removed or a depression in the cope side of casting. This method of running will produce nice clean castings with any kind of copper and is equally as valuable for a 5 per cent zinc-copper, as for silicon.

Horn Gate.

For deep castings the horn gate gives best results. Some copper castings for electrical work have large flanges which rise high into the cope, and run deep into the nowel, and if the casting is gated so the metal must plunge to the bottom of this flange, "drossy" and "skummy" castings will result. Therefore, a horn or other suitable gate should connect with the deepest part of the flange, and a small riser be taken off the top of the same. If there are angles where thick and thin sections join, heavy feeders will be necessary at these points to prevent shrinkage cracks.

Sometimes the risers will have to be placed right on top of the casting, the same as for steel, and such risers must be larger in proportion to the part they are to feed, than would be required for steel. Should the riser be too small, the casting will prove it by means of a shrinkage cavity right under the same. A round copper bar was cast, 4 inches in diameter and 15 inches long. The molder "drew" the pattern to 20 inches, to give a 5-inch sullage head. It was molded perpendicularly and when the head was cut off, a pear-shaped cavity, 2 inches in diameter, was found in the casting directly under the feeder.

Shrinkage Cracks.

Shrinkage cracks are another disease to which heavy, pure, copper castings are exposed at places where a heavy flange connects with a thinner part of a casting or where any heavy section is joined to a lighter one forming an angle. This is the danger spot, and that is the place to put a feeder, which will always remedy the defect, provided the feeder is large enough.

Silicon-Copper as a Deoxidizing Agent.

Figs. 3, 4 and 5 are examples of copper castings in which 1½ per cent of silicon-copper was used to de-oxidize the metal. Fig. 3 was cast in the same manner as Fig. 1. It was run by a horn gate at A, the feeder being placed on the end B, which was the highest point of the casting. When first cast, the feeder was too small and the casting shrunk at C. Heavier feeding remedied this trouble.

Fig. 4 had a tendency to "shrink crack" at D. This was molded on its side, the flange being perpendicular. A heavy feeder on the back of the flange insured good castings. It was gated on the bottom of the flange with a horn gate.

Fig. 5 is a troublesome shape, as it would crack at E and H. It was ultimately made successfully, by being

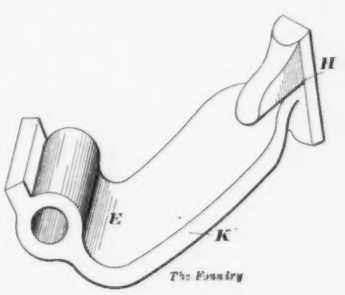


FIG. 5—COPPER CASTING

molded on edge, a heavy wedge-shaped shrinker being placed at K and a feeder at H. It was poured from the bottom with a horn gate.

Effect of Silicon-Copper on Bronze.

To test the effect of silicon on bronze the following alloy was tried:

Copper, 16 pounds; tin, 1½ pounds; zinc, ¾ pound; lead, 6 ounces.

This is a good medium hard bronze. To this was added 12½ ounces of silicon-copper. Part of the alloy was cast in ingots and part in sand.

The ingots had a fine appearance, smooth on top, with a depression in the center, but the sand castings came out covered with a white deposit, which was not removed by chilling in water. The castings were exceedingly dirty, being full of white dross (silica). The fracture was

inclined to the crystalline, and the color of the metal was yellowish red.

The castings were of no value, they were remelted and again cast without any improvement in the sand castings. The ingots were of a bright appearance with a dense fracture of a grayish drab color. The strength of the metal was not improved by silicon.

This alloy was tried a second time, the silicon copper being reduced to four ounces. The castings still showed white. They were remelted and improved to a natural bronze color, with no external trace of silicon.

To determine the cause of the white dross, the following experiments were tried:

No. 1—Copper, 30 pounds; tin, three pounds and five ounces; silicon-copper, one pound.

This alloy cast well, the castings being bright and silvery with a reddish tint. The fracture was not homogeneous, and a 1¼-inch test bar when broken showed a light brown spot in the center surrounded by a ring of grayish metal.

No. 2—Copper, 10 pounds; zinc, five pounds; silicon-copper, eight ounces.

The castings were bright yellow externally, and very tough and ductile. A 1¼-inch test bar was sawed half through and bent double, but would not break.

No. 3—Five pounds of No. 1 and five pounds of No. 2 were melted together.

The castings were free from white deposit, a trifle drossy, but careful gating would eliminate this. Alloy of no particular value.

No. 4—Copper, five pounds; lead, one pound; silicon-copper, four ounces.

This alloy will not cast in sand. The castings were heavily coated with white powder, and full of surface holes filled with the same. Lead, therefore, seemed to be the cause of dross in silicon-bronze and to determine this with certainty a fifth alloy was tried.

To six pounds of No. 3 alloy were added two pounds of No. 4. The castings were similar in every respect to No. 4. This, and further experiments along this line, removed all doubt that lead, even in minute quantities, must be excluded from all alloys containing silicon.

In conclusion, I repeat that silicon has much the same effect on copper alloys as aluminum, with the difference that its bad qualities are more easily overcome. Silicon, like aluminum, exercises the greatest influence on the copper-zinc alloys, and to me there is no doubt that if this influence were better understood, by the makers of the yellow brass castings, there would be a decided increase in the consumption of silicon-copper.

MOLDING A DIFFICULT CASTING

A Simple Method of Making a Complicated Section Which Greatly Reduced the Cost of Production

BY H. J. PFAINDLER

TO MAKE ordinary small castings at a low cost is not a very difficult task in these days of improved methods, but to be able to keep down the cost when some casting is to be produced at a low price is an entirely different problem.

For instance, if it is an ordinary gated pattern for which a plaster follow board is all that is required, it is very easy sailing, but if it should be a pattern of peculiar shape requiring a three-parted flask and perhaps one parting to be made by hand for every mold made, it is not quite so easy to know how one is going to succeed.

Small Difficult Casting.

I have a particular pattern in mind which caused considerable grief in our foundry before we were able to get anything like good results. It was a small casting weighing about three pounds which was hollow, much like a shoe for a well bucket sheave. We tried various methods of ramming up with two follow boards with openings at the ends to ram in sand. We also tried one follow board to form the parting on only one side of the pattern making one parting by hand. As the shape of pattern was very irregular, we soon found that this way of making the casting would put us out of business in a very short time as a molder could not possibly make over 12 molds a day, four patterns in a flask.

We finally devised a method that may not be new, but is, nevertheless, interesting. Fig. 1 shows a gate of four patterns; Fig. 2 shows one-half of four patterns which are gated and setting in one follow board, and four half patterns in the other follow board. The follow boards are fitted with butt hinges which have loose pins in them. These boards are set edge to edge on the bench and rammed up in the regular way, and struck off with a thin hard wood strike.

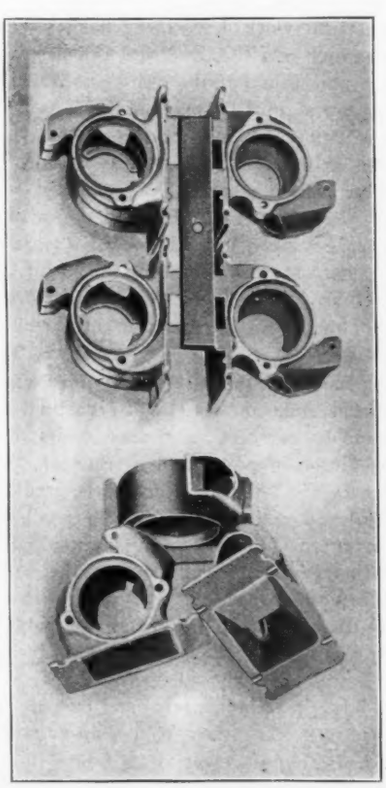


FIG. 1—A GATE OF FOUR PATTERNS. THE CASTINGS ARE SHOWN BELOW

The Patterns.

As will be seen in Fig. 2, the patterns are split exactly in the center and are sunk in the hollow boards just far enough to have their upper edges come flush with the top edge of the follow boards. This permits striking off all surplus sand. The boards are then closed together by setting both up on edge at the same time, as shown in Fig. 3. This operation is very much like closing a book, thus avoiding any chance of the patterns dropping out of place. Both pins are then pulled out of the hinges and one board lifted off, as shown in Fig. 4, giving a perfect parting to every part of the patterns. The cope is then put on and the sprue is set in place and rammed up in the regular way, putting on a bottom board and rolling over, removing the other half of the follow board which makes the parting for the other side of the patterns. Everything

is then ready for the drag to be rammed up and lifted off. The four loose patterns are then drawn out, drag closed down and the whole flask rolled over again. Then the cope is lifted off and four gated patterns removed. The cope is next returned and the mold is finished.

This may seem a very long process to go through, but when everything is in working order it is a very rapid way of making this sort of a casting, as any one can prove by trying the old way and then the other. By using this method we are able to get 33 molds a day, as compared with 12 by the former method. We also get a much better casting as all parts are rammed and not tucked as is necessary in nearly all three-parted jobs. We found from experience that it was not practical to gate patterns for both boards as a very slight wearing of the hinges on the follow boards moved the patterns out of place when the two boards were closed together, and they would not match up well. By leaving four halves loose in one board they easily adjusted themselves to their places when coming together.

No matter how irregular the shape of the pattern, by the use of the two follow boards in this way a very complicated casting can be made almost as easily as if the pattern were plain along the parting lines.

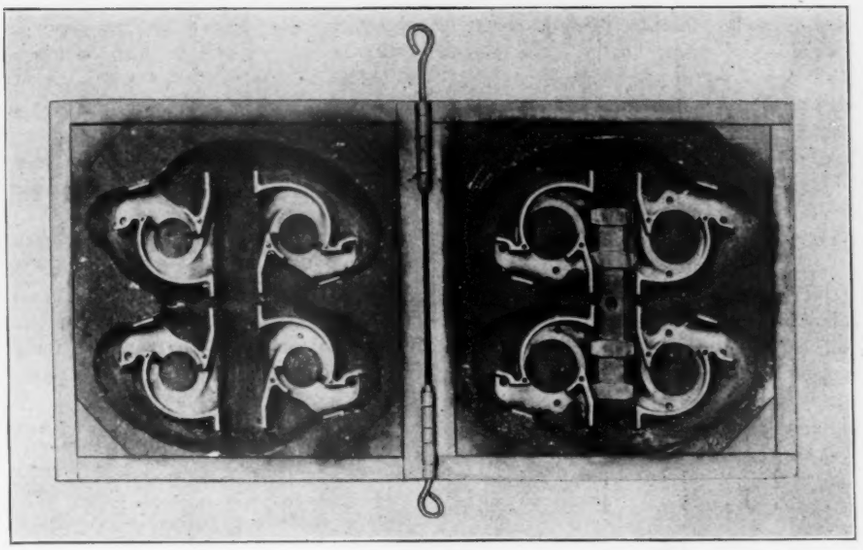


FIG. 2—ONE VIEW OF FOUR GATED HALF PATTERNS IN ONE FOLLOW BOARD, AND FOUR HALF PATTERNS IN THE OTHER

DIFFICULTIES EXPERIENCED MIXING DIFFERENT GRADES OF IRON.

BY R. H. MCDOWELL

Foundrymen generally experience considerable difficulty mixing iron to secure certain desired results. The use of ferro-alloys is also misunderstood by many practical founders, and notwithstanding the fact that directions are carefully followed results are not as they should be. The furnace operators are often at fault inasmuch as they frequently fail to clearly indicate the mixtures for which their brands are best adapted, and the chemists do not outline the proper use of alloys which have already overcome many of the difficulties that beset foundry work.

Fusing of Iron.

Many mixtures of different grades of iron fail because the laws controlling the fusing of iron are ignored. Mixtures frequently fail, not because the iron and alloys are not of the proper quality but because the foundrymen believe that their work has been done when the proportions are used as directed and the charge has been dumped into the cupola. When the castings are cleaned it will frequently be found that conditions have not been changed and that the difficulties that were to have been overcome, still exist. The foundrymen seek explanation from the chemist and furnace operator and are given the same old story about mixtures, with possibly a suggestion of some slight variation in the proportion of the irons and alloys. Conditions under which these alloys combine or fuse into a homogeneous mass are wholly ignored.

Combination of Alloys.

And what are these conditions? When the various elements necessary to make cast iron are combined to show a smooth, even grain, the structure being the same throughout the mass, we say that the homogeneity of these elements is perfect.

Note the exception. Phosphorus will form a perfectly homogeneous mass with iron under certain conditions, but if silicon or manganese is tried under the same conditions the results would be entirely different.

To illustrate, we will assume that a good clean grade of cast iron will melt at 1,400 degrees Cent. When I say a clean grade of iron I mean one showing the following analysis: Total carbon, 1.05 per cent; combined carbon, 0.15 per cent; silicon, 0.85 per cent; sulphur, 0.02 per cent; phosphorus, trace.

If this grade of iron melts at 1,400 degrees Cent. and to this is added iron containing 1 per cent of phosphorus it will melt at 1,300 degrees Cent. If to this is added about 2 per cent of silicon the melting point will be raised to 1,500 or 1,550 degrees Cent. A high phosphorus iron will melt at the lowest temperature, a high carbon iron next, a high sulphur iron next, and a high silicon iron requires about as high a temperature to melt as any of the iron alloys in use in foundries.

Alloying Phosphorus.

This means that to alloy phosphorus with cast iron it is not essential that the

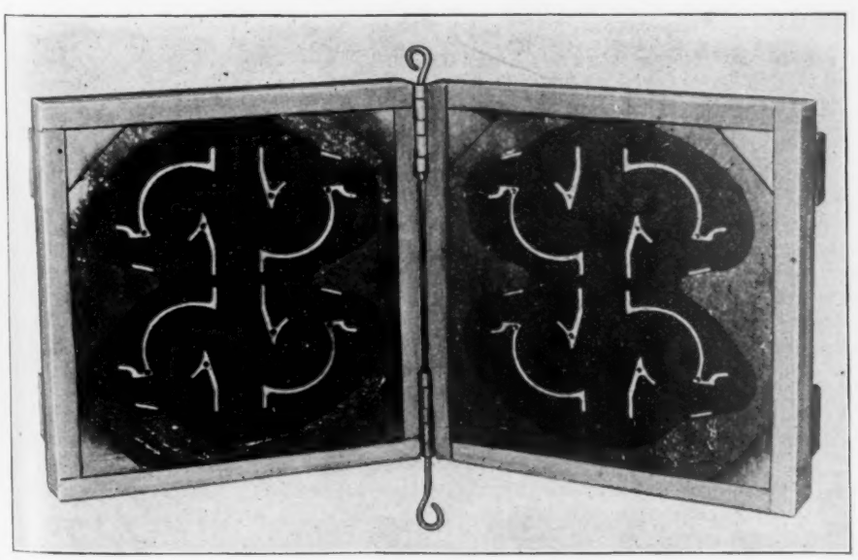


FIG. 3—FOLLOW BOARDS ON EDGE BEFORE CLOSING

iron is melted hot to form a perfectly homogeneous mass, but to alloy silicon with cast iron for the purpose of reducing combined carbon, it is very essential that the iron is melted at a white heat that it will be fluid enough to permeate the entire mass and combine with the carbon and reduce it to the graphitic state.

Since it is known that it requires a white heat to melt silicon does it not follow that to alloy silicon with iron, it will be necessary to raise the temperature of the iron sufficiently to thoroughly liquify the silicon or it cannot permeate the mass and do its work?

Again, to soften a high carbon iron with silicon it is well to know that the higher the temperature of a high carbon iron is raised, the weaker becomes its affinity for carbon and iron, and the stronger its affinity for carbon and silicon.

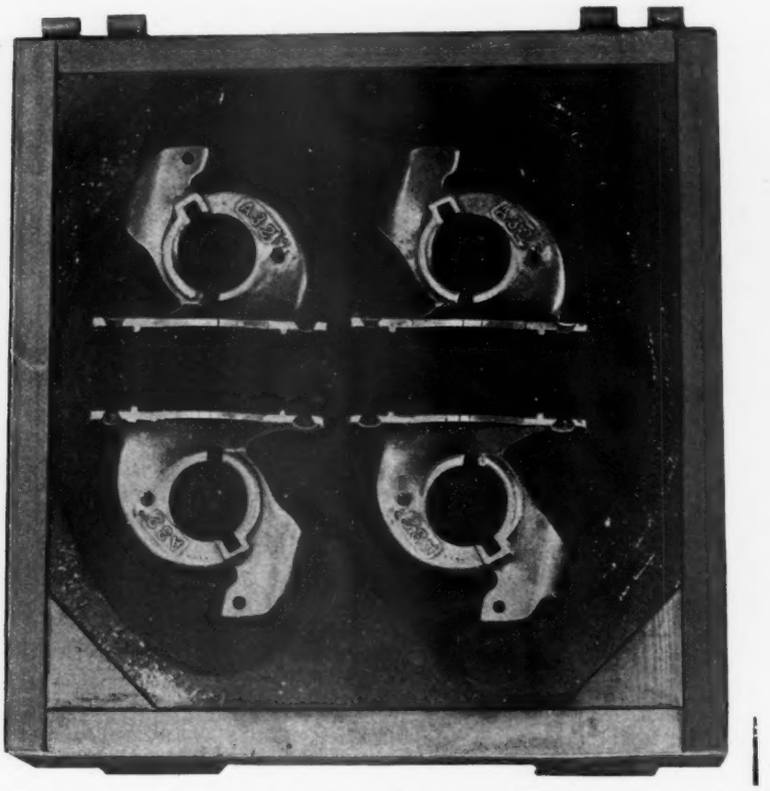


FIG. 4—FOLLOW BOARD LIFTED OFF AFTER THE PIN IN THE HINGES HAS BEEN REMOVED

Use of Manganese.

Many foundrymen are using manganese for the purpose of producing a chilled surface on castings and are complaining because the chill is not deep enough or it is uneven, or the chilled portion seems to be distinctly separated from the inner or unchilled portion.

What conditions are essential to produce a deep chill on a casting?

First—Iron high in graphitic carbon with a fairly high per cent of combined carbon. The amount of graphitic carbon present should depend on the depth of chill required. The iron must be low in sulphur.

Second—A good grade of coke, low in sulphur and ash.

Third—A temperature above the melting point of silicon and manganese, which is a white heat.

Iron high in graphitic carbon means that the iron has a high percentage of carbon within its structure but the greater portion of it is rendered inoperative in the iron as it has entered in combination with silicon forming a compound which has no hardening effect on the iron like the carbon, by itself, would have.

If manganese is introduced in this iron and the temperature is high enough, the manganese will combine with the silicon liberating the carbon; when a sudden chill is brought to bear on the liquid iron containing this free carbon, it is driven into combination with the iron forming the chilled surface on the castings.

Depth of the Chill.

The depth of this chill depends largely on the amount of free carbon in the iron. If the chilled surface blends gradually into the inner or softer iron it shows that the fusion and chemical changes have been thoroughly carried out. If the chilled portion of the casting shows a distinct line of separation between it and the unchilled portion it reveals an imperfect fusion and a high percentage of impurities which may have been expelled had the fusion been perfect.

Note the effect of imperfect fusion and certain impurities in the iron in attempting to secure a chilled surface. Manganese and silicon fuse at a white heat but like iron, manganese will combine with sulphur at a temperature far below the fusing point of iron, but after this combination has taken place the fusing point of the sulphide formed rises to nearly that of manganese. Therefore, if the coke or iron has an excess of sulphur, the manganese added to reduce the graphitic carbon will combine with the sulphur and pass off with the slag, the graphitic carbon remaining the same in the iron and consequently there is no chill.

If the iron is melted at a temperature above the melting point of manganese sulphide, the sulphide will be decomposed and the sulphur driven off leaving the manganese to do its work with the graphitic carbon, but the work will not be as well done as it would have been had there been no sulphur to contend with.

A closer study of these many important points will help foundrymen out of their troubles and will add many dollars to the profit account instead of placing them at the debit side of the ledger.

STUDENTS WILL STUDY THE CUPOLA.

Officers and students of the metallurgical department of Columbia university are carrying on a series of studies upon cupolas in the neighborhood of New York city, in order to learn, if possible, the effect of different heights of fuel bed and thicknesses of charges of iron and coke on the fuel economy of melting. The purpose is not to investigate any one foundry in detail, or to vary the practice in any cupola, but to obtain data on several different cupolas to get as complete a basis for comparison as possible in this way. Besides the dimensions of the cupolas and their parts, pressure of blast, weights of charges, etc., measurements will be made of the actual temperature of the iron, and, if possible, the actual volume of blast and a limited number of analyses of the gases from the top. Any suggestion or assistance from foundrymen will be gratefully received and should be addressed to the Department of Metallurgy, Columbia university, New York.

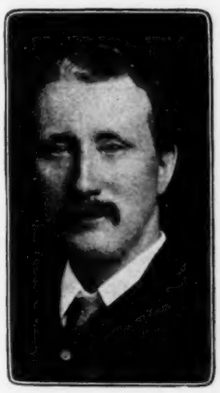
MANGANIN.

This alloy is made up as follows: Copper, 82.12; nickel, 2.29; iron, 0.57 and manganese, 12. It is used for electric resistance boxes and owing to the presence of nickel has a very high fusion point and an extremely low coefficient of temperature.

THE ADVANTAGES OF CORE MOLDING

This Method of Making Molds Effects Great Economies in the Foundry—Adaptability to Various Castings

BY J. F. BUCHANAN



WITH the exception of repetition work, which is mostly made on machines, molding methods are trite, accommodating, reciprocal processes, untrammeled by the mechanical niceties. Individuality, originality and "atmosphere," are still within the range of foundry practice, as molding is one of the few trades in which pride of craft is not wholly dead and the creative powers have full scope. On occasions, the molder may blow meditative smoke-rings around a knotty problem; may see visions of form and color like any other artist; may work out the harmony of mind and matter in his own way, and with his own tools and methods, may produce "high art,"—even from the pit, conquering in the battle with the elements, at the furnace mouth, or on the sand heap, and finally reaching his ultimate triumph when the finished casting proves its value in the service of humanity. Thus does the molder justify his calling and uphold the dignity of labor.

Having paid this tribute to the molder and his methods,—the molder, who is so frequently execrated as a fumbler, and his methods, which are so often treated as x in algebra,—the writer feels he can the more freely present some thoughts on core molding, an ideal foundry process, to the candid judgment of the practical foundryman.

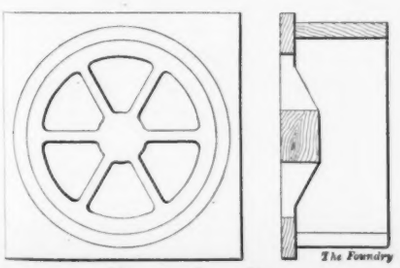


FIG. 2—CORE BOX

Core Molding.

Of all the methods of making molds, the least popular is undoubtedly what, for want of a better term, we have called core molding.

The beginning of this new but undeveloped feature of modern foundry practice may be traced to the use of "cover cores" and "loam cakes,"—makeshifts for the regular cope, or to save an additional parting at some necessary joint or loose piece on the pattern. A core is generally defined as that part of the mold which determines the internal form of the casting. In the ordinary routine of sand molding the cavities desired in the

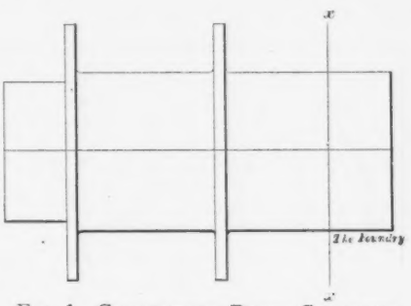


FIG. 1—CIRCULATING PUMP CHAMBER PATTERN

casting are attended to by the core making department, but when the external parts have to be dealt with, molding—green sand, dry sand, loam—is the only way.

Core molding is a new departure signifying the process of making molds from cores, or sand pieces made by the use of core boxes, to form the external as well as the internal figure of the casting.

Since the core means the heart of anything, to talk about external coring may seem nonsensical. Not being clever enough, however, to coin a new word for this process, core molding, or to be more explicit, core box molding, may apply, even although there may be a great deal more of patternmaking and core making than actual molding in the work by this method.

A great many foundrymen dislike to hear much about cores; they have an idea that cores and catastrophies keep company. Some have deeply rooted convictions that a core leaves one kind of a hole in the casting and a bigger kind of a hole in the profits. Others have doleful presentments as to the fickleness of cores in general and the migratory tendencies of "jacket" cores in particular. All the traditions of the trade and the natural bias of the foundryman's experience are consequently against the free use of cores in any case. But as for molding with cores the idea conjures up visions of extravagance, worry and disappointment, and it seems to accentuate the foolishness of introducing patternmaker's theories into our ordinary and comfortably established foundry practice. Such are the off-handed opinions of those who have not given careful study to the core box method of getting out castings.

Skeleton Patterns.

Readers of THE FOUNDRY have already been well informed of what can be done in the way of molding large pulleys, fly wheels, lathe beds, floor plates, etc., without patterns in the ordinary sense of the term. A skeleton, or a few loose bars, arms, ribs or web pieces, and roughly made core boxes, may be made to serve the purpose of a highly finished, expensive pattern, and, at the same time, reduce the labor and material cost. With the intent of trying to break down some of the unreasonable prejudices already referred to, and to stimulate the general study of the principles involved, the writer has chosen a few of the simplest examples in his experience, to illustrate the uses of core boxes in avoiding practical patternmaking difficulties, and the convenience of core molding in foundry practice.

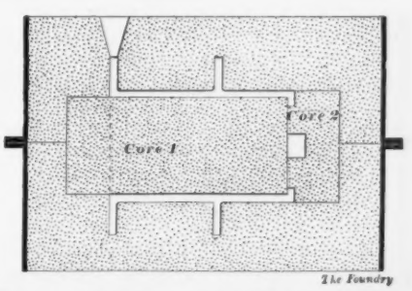


FIG. 3—SECTION OF THE MOLD FOR CIRCULATING PUMP CHAMBER

Pump Chamber Casting.

It is an unusual proceeding to cast the guard on to the bottom of the circulating pump chamber, Figs. 1, 2, 3 and 4. As it was necessary in this instance, either the patternmaker or the molder was bound to have some extra trouble to

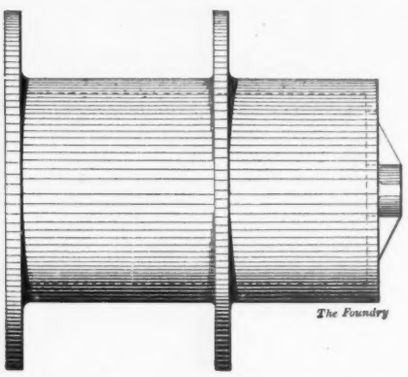


FIG. 4—CIRCULATING PUMP CHAMBER CASTING

get it out. After a consultation between the two, it was decided that the simplest and safest way for both parties, was to lengthen the pattern diameter at X to form a print and then make a core box containing the grid portion. Fig. 2 brings into relief the first important gain of the *outside* coring methods, as loose pieces, with their accompanying troubles, are avoided in the pattern. Every loose part in the make up of a pattern shortens the life of the same and increases the difficulty of obtaining true castings therefrom.

The difficulty of keeping these pieces in correct register while ramming the mold, and the awkwardness of withdrawing them, adds considerably to the molding risks and expense, chiefly by weakening the mold and making patching inevitable. By butting cores 1 and 2 together in the mold, a more accurate and economical casting would result than by having an independent mold part for the guard on the end. It should also be evident from the sketches, that the work of patternmaking is simplified.

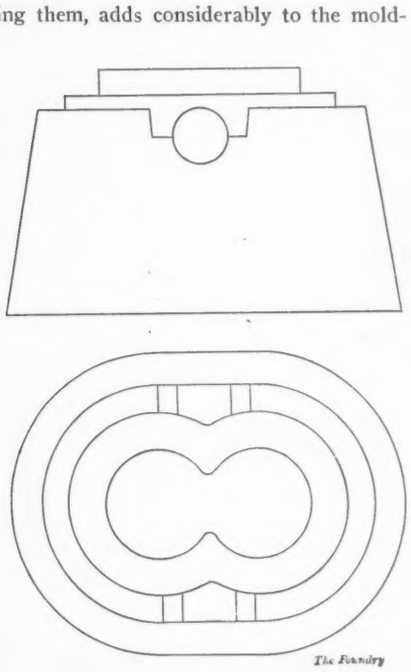
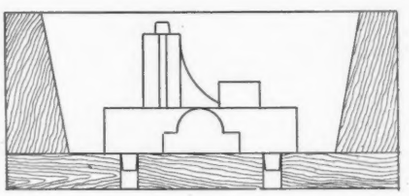


FIG. 5—PATTERN BLOCK FOR PUMP CASTING

Another Pump Casting.

Figs. 5 to 9, illustrating another kind of pump casting, provides a good example in the next stage of the core molding process. In the first example a print was added to the outer part requiring the core for its formation, but in the second, which is a more advanced type, the whole of the pattern becomes, to all intents and purposes, a print. Another advantage is here revealed in the fact that skilled



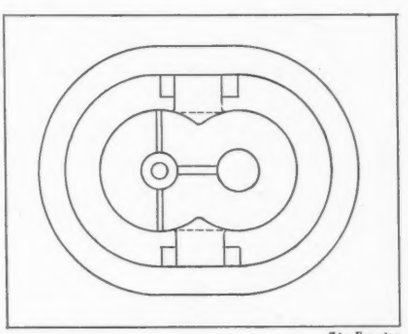


FIG. 6—SECTIONAL VIEWS OF THE CORE BOX

molders are not required, only coremakers, to do this class of work. The pattern in this case is a solid block with only the bottom outline of the intended casting cut in, as shown in Fig. 5. The bedding down of the pattern block, and the making and placing of two cores, inner and outer, Figs. 6 and 7, completes the labor of preparing the mold, Fig. 9. The gate is cut in a "cover core."

Propeller Wheel.

Having shown the easy gradation from the pattern and core method of molding, we are now prepared to consider whether the pattern might not be dispensed with altogether. The propeller wheel is a standard piece of work in marine engineering, and the methods of making it have been pretty well standardized. The idea of molding by cores, as applied to propeller wheels, is novel; and as I have proved by actual experience, it is practical, economical and mathematically correct.

For large propellers the truest and safest method of building the mold is, undoubtedly, the loam molder's methods; but for medium and small-sized wheels,

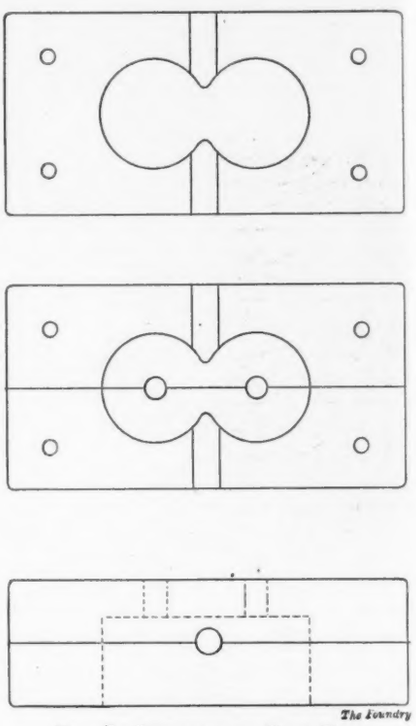


FIG. 7—INTERIOR OF CORE BOX

say from 4 feet in diameter down, the cored mold has many advantages over the other sand molding methods, in the ramming, fitting, handling and accessibility of the parts. No drawbacks to the mold and less fin to the casting, and the patternmaking expense reduced to the making of one-half core box, Fig. 11, and the blade pattern, Fig. 10. For a three-bladed propeller six cores are made from the box, Fig. 11, three with the blade pattern in position (tops) and three without (bottoms), Figs. 13 and 14. These illustrations show how the cores are set out and fitted together to make the mold. The internal prints are tinted white, and the core sections are loosely arranged *on purpose,* to show the joints.

The molding labor is small in comparison with the ordinary methods. It consists in striking up a bed on which to assemble and curb the cores ready for cast-

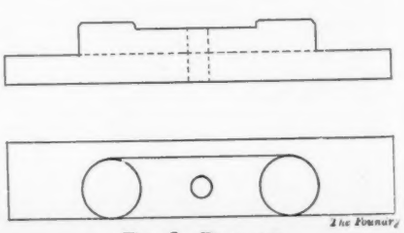


FIG. 8—BRACKET

ing. After the cores have been fitted in position, the ordinary means of binding the mold and casting are employed. The core making, which is about four-fifths of the work, is straightforward and simple, with no pitfalls nor unforeseen intricacies.

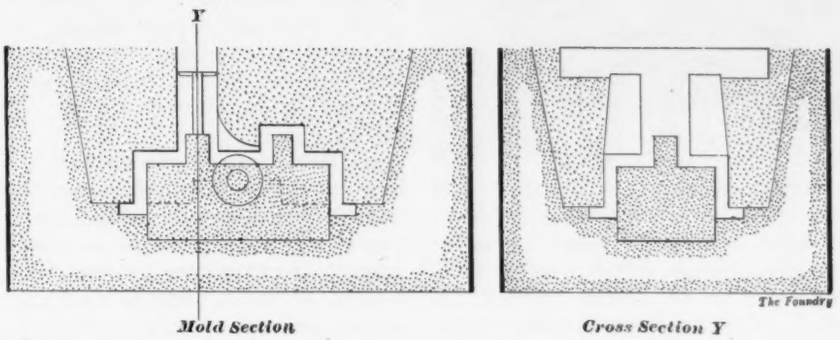


FIG. 9—SECTIONAL VIEWS OF THE GREEN SAND MOLD

Large Propeller Blades.

For blades of large area, a plain grid core arbor, with screwed hangers, facilitates the handling and setting of the cores. Finally, the gates are cut through the top print of the inner hub core as shown. Propellers made in this way are accurate as to pitch, and all the mold sections being made from one core box, they are perfectly balanced.

The propeller wheel and how to make it, has always been a favorite subject of study with foundry operatives. It is a familiar casting, and to the average foundryman the methods of making it are very ordinary molding processes. Here, it has been my aim to show how the principles of "the coming process," core molding, may be applied to the old familiar castings and the ordinary processes.

Practical Benefits of Core Molding.

However, having shown the practical benefits of core molding as they apply to some of the most familiar castings, others may be led to study more minutely the convenience of assembling a few cores, instead of having to mold an intricate object. The foundrymen who are obsessed by the bugbear of patternmaking and core making costs will have to rearrange their ideas of economy soon. Core molding is not only a method of convenience for intricate castings; it is a method of economy with satisfactory results. Castings by this method are equal to the best loam finished work and because a core mixture is used, the molds are more open and less liable to scab. No hard and fast rules can be laid down about any molding method. Sometimes loam is the most suitable method, sometimes green sand or dry sand.

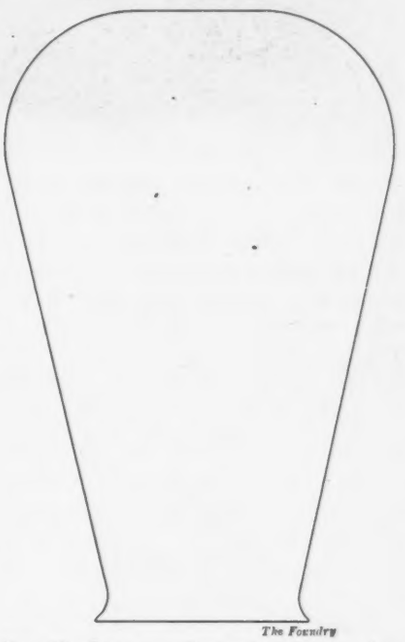


FIG. 10—PLAN OF PROPELLER BLADE AREA

One feature about core molding is its adaptability. It may be used in conjunction with any of the other methods. The first example we selected, Fig. 1, was a dry sand job. In the second case the mold proper (what there was of it) was in green sand, Fig. 9.

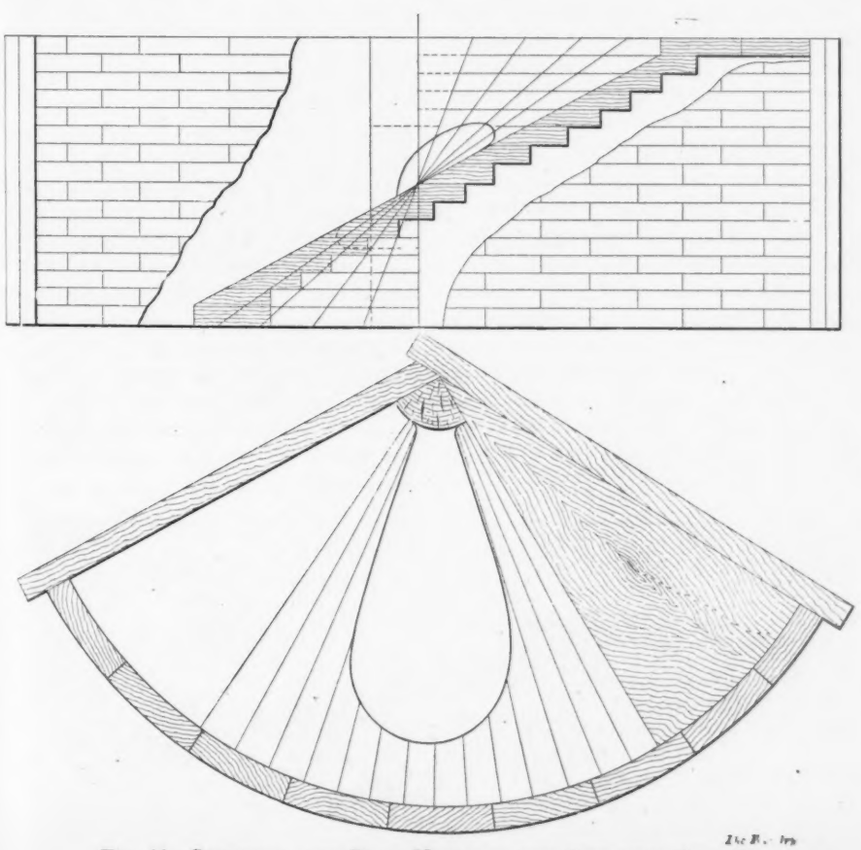


FIG. 11—SECTIONAL AND PLAN VIEWS OF THE PROPELLER CORE BOX

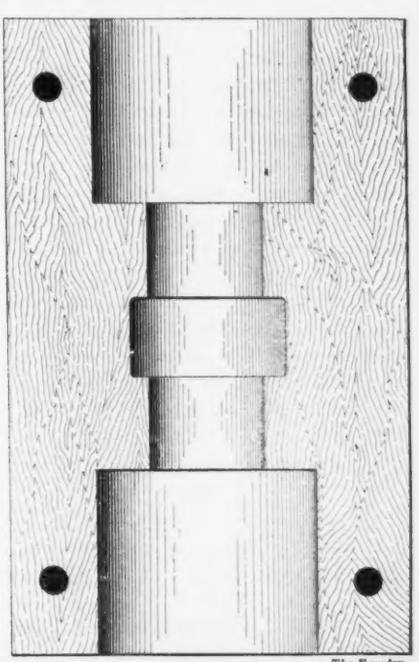


FIG. 12—HALF CORE BOX FOR THE HUB OF THE WHEEL

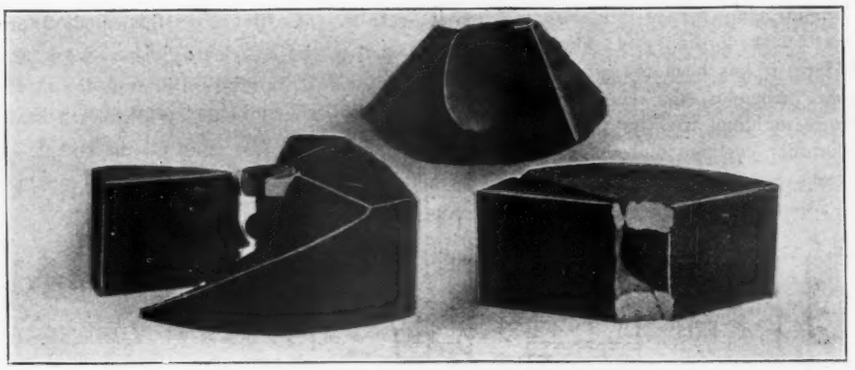


FIG. 13—CORES FOR PROPELLER MOLD

Bell Castings.

As a further illustration of the possibilities of combining core molding with other methods, take the bell in Fig. 15. This is a loam job, but the crown hanger is much simplified if two half cores, Fig. 16, are let into a print in the cope. Other uses of core molding must suggest themselves, as, for example, the multiple molding of small flat top castings, by placing core molds, one above the other.

The Foundry

FIG 15—BELL CASTING

Probably the best argument for the consideration of core molding methods is the fact that the molder, the pattern-maker and the coremaker are brought into closer touch when they are adopted. There is not the same danger of core molding becoming a mere fad when all hands are interested in discussing the merits and demerits of the process on a particular job. Molding is a progressive art and the observant tradesman, if he uses his experience properly, will improve on the methods of his predecessors.

THE CUPOLA IN BRASS FOUNDING.

BY EDWARD KIRK

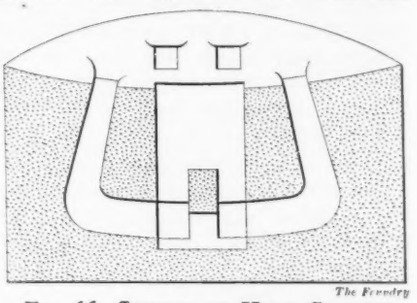
A series of tests have recently been made to determine whether brass, bronze, etc., could be melted in a cupola as economically and with as good results as in some of the other types of melting furnaces. These tests showed that the metal could be readily melted in the cupola and could be made sufficiently fluid to run the lightest castings. The average melting ratio was 10 pounds of metal to 1 of coke. The average loss on yellow brass was 3 per cent and red brass and bronze 1 per cent, analyses of metal, before and after melting, showed less change in the alloy than with some other types of furnaces. Zinc and other metallic fumes were not great and the metal was melted as fast as the molders could pour it, and was as hot and fluid as desired. These tests showed that the cupola possesses many advantages for melting scrap and alloyed metals but was found to be deficient in making alloys of metals, as the more fluid metals melted more rapidly than the copper and it was found difficult to get the required amount of these metals in the alloy. This difficulty could be readily overcome, however, by melting the copper in the cupola and the more fusible metals in iron pots or ladles, making the alloy in the ladle after the copper is melted in the cupola.

Melting Borings and Turnings.

Tests made with turnings, borings, etc., showed very poor results as the loss of metal was very heavy and the alloy of the metal after melting, unsatisfactory. These results could probably have been improved had the turnings been placed in wooden boxes to hold them in a compact mass until they reached the melting zone, but this was not tried.

That the cupola can be utilized to advantage in the melting of brass and bronze is well known, and it has been used at the United States navy yard foundry, Washington, D. C., for a number of years for all heavy castings. In the foundry of the Southern Railway, Manchester, Va., metal for all the brass and bronze castings used is melted in a cupola constructed for this purpose. In this furnace various new alloyed metals and also old metals are melted.

In many cases where brass and iron foundries are under the same management, the brass and bronze for heavy castings are melted in the cupola of the iron foundry with satisfactory results and the metal is poured with the iron foundry ladles which are convenient for this purpose. When these ladles are used they should be raised to a red heat before filling the first time. To prevent oxidation in the ladles, the metal should be covered with charcoal.



The Foundry

FIG. 16—SECTION OF HALF CORE FOR BELL MOLD

That the cupola possesses many advantages for brass foundry use there is no doubt, as it melts the metal at a low cost and there is only a slight loss. With a cupola, a brass foundry can be operated on the iron foundry system, and a full day's work can be done on the molding floors before casting. Metal from the dump of the cupola, gangways, etc., can all be recovered by the iron foundry system of tumblers and separators which is not as a rule recovered from the ashes by the brass founder, and the per cent of metal lost in this way is considerable.

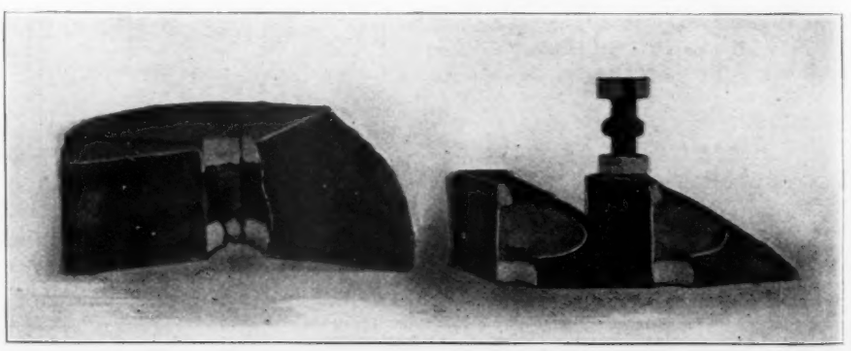


FIG. 14—CORES FOR PROPELLER MOLD

MEASURING THE CAPACITY OF LADLES

An Easy Method of Ascertaining the Amount of Iron in Ladles With a Gage Bar

BY A. C. HEMIST

SOME time ago the writer had occasion to use a six-ton ladle to pour a number of pieces varying in weight from 4,500 to 9,000 pounds, and as the pieces in question had to be made of special iron which could not be used in the other castings being made at the time, it was necessary to gage the amount taken in the ladle very closely.

The ladle used was of standard size and was furnished by a very prominent foundry equipment house. The writer thought that undoubtedly a house of this character would have tables showing the capacity of their larger ladles at each inch in depth, and wrote them for this information concerning the ladle in question, receiving in reply the following:

> Dear Sir:—The ladle in question has a capacity of six tons, and you can approximate its capacity at different depths as follows:
> When 1/3 full it will contain 2 tons of iron.
> When ½ full it will contain 3 tons of iron.
> When ¾ full it will contain 4½ tons of iron, etc.
>
> Trusting the information will enable you to obtain the desired result, we remain,

This reply was very unsatisfactory, and the information was useless as the taper in the ladle made it practically impossible to tell when it was one-third, one-half or three-quarters full. The writer, therefore, had to figure the capacity of the ladle at each inch in depth, and decided to construct a table showing the capacity of all the larger ladles in his possession, at varying depths, and also made a gage for measuring the depth of iron in the ladles. This table and gage have been in daily use in this foundry for some time, and have been found almost invaluable, and knowing a number of foundrymen who are experiencing the same trouble, thought these tables and the method of constructing and using them might be of considerable interest to the trade.

Estimating Weight of Circular Castings.

In figuring these tables the writer improved on the original method in several ways. At first the old rule for finding the weight of a circular plate was used (multiply the square of the diameter by the decimal 0.7854 and the quotient by 0.2632). This gives the weight of a plate 1 inch thick, but afterwards this method was shortened by multiplying the decimal 0.7854 by the decimal 0.2632, thus obtaining a new decimal 0.206717, or practically 0.206, which reduces the square of the diameter of a circular body of iron 1 inch thick directly to pounds.

This method is now used entirely by the writer in figuring the weight of circular castings and shortens this work more than one-half. It can be given in the form of a simple rule as follows:

> To find the weight of a circular body of cast iron 1 inch thick, multiply the square of the diameter by the decimal constant .206.

On account of the taper in the ladles, each inch had to be figured separately, and the resultant weights added successively, thus giving the capacity of the ladles at each inch in their depth. This method was followed in constructing the table.

Expansion of the Iron.

A factor which at first caused considerable trouble was the expansion of the iron. It is a well-known fact that all metals expand as their temperature increases. The amount of their expansion varies with the different metals, and by experiment a co-efficient of expansion has been determined which differs for

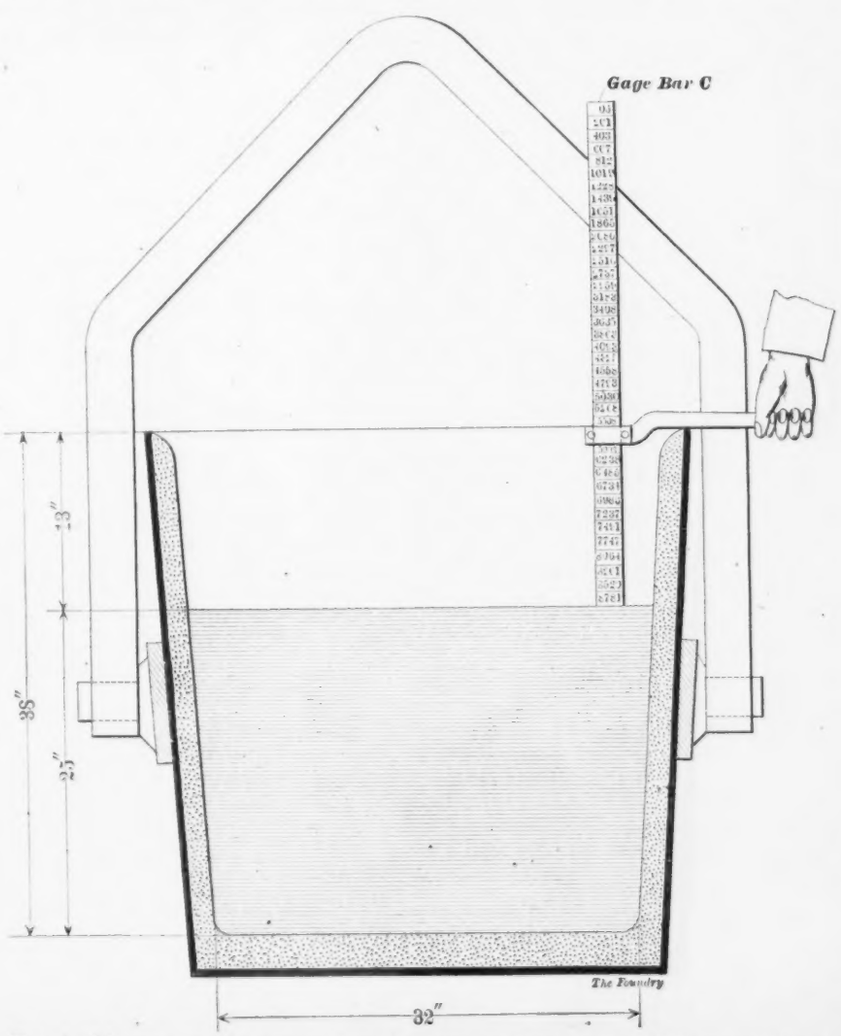


FIG. 1—METHOD OF MEASURING THE AMOUNT OF IRON IN AN 8,000-POUND LADLE WITH A GAGE BAR

Editor's Note.—The first prize was divided between A. C. Hemist and C. Vickers, this article being awarded one-half the first prize in the contest conducted by THE FOUNDRY.

DIAMETER OF LADLE AT THE BOTTOM IN INCHES.

Iron in ladle, inches.	20	20½	21	21½	22	22½	23	23½	24	24½	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1	78	82	86	90	95	99	104	109	113	118	123	133	143	154	165	177	189	201	214	227	240	254	269	283	299	314	330	346	363	380	397
2	157	165	173	181	191	199	209	219	227	237	247	267	287	309	332	356	379	403	429	455	482	510	540	568	600	630	662	694	728	762	796
3	237	249	261	273	288	300	315	330	342	357	372	402	433	466	500	536	571	607	646	685	725	767	813	855	903	948	996	1,044	1,095	1,146	1,197
4	318	334	350	366	386	402	422	442	459	479	498	538	580	624	670	717	764	812	865	917	970	1,026	1,087	1,144	1,208	1,268	1,332	1,396	1,464	1,532	1,600
5	400	420	440	461	485	506	530	555	577	602	626	676	728	784	841	900	959	1,019	1,086	1,150	1,217	1,287	1,363	1,435	1,515	1,590	1,670	1,750	1,835	1,920	2,006
6	483	507	531	557	585	611	639	669	696	726	755	815	877	945	1,014	1,084	1,155	1,228	1,308	1,385	1,466	1,550	1,641	1,728	1,824	1,914	2,010	2,106	2,208	2,310	2,414
7	567	595	623	654	686	717	749	784	816	851	885	955	1,028	1,108	1,188	1,270	1,353	1,439	1,532	1,622	1,717	1,815	1,921	2,033	2,134	2,240	2,352	2,464	2,583	2,702	2,824
8	652	684	716	752	788	824	860	901	938	977	1,016	1,096	1,180	1,272	1,364	1,457	1,552	1,651	1,756	1,860	1,969	2,085	2,203	2,330	2,446	2,568	2,696	2,824	2,960	3,096	3,236
9	738	774	811	851	892	932	972	1,019	1,061	1,105	1,149	1,239	1,334	1,437	1,541	1,646	1,753	1,865	1,984	2,100	2,223	2,354	2,486	2,629	2,760	2,898	3,042	3,187	3,340	3,493	3,651
10	825	865	907	951	997	1,041	1,085	1,138	1,185	1,234	1,289	1,383	1,489	1,604	1,720	1,836	1,955	2,080	2,212	2,342	2,479	2,625	2,771	2,930	3,076	3,230	3,390	3,552	3,722	3,892	4,068
11	913	957	1,004	1,052	1,103	1,157	1,199	1,258	1,310	1,364	1,418	1,529	1,646	1,772	1,900	2,028	2,159	2,297	2,442	2,585	2,736	2,898	3,058	3,233	3,394	3,564	3,740	3,919	4,106	4,293	4,487
12	1,002	1,050	1,102	1,154	1,210	1,262	1,314	1,380	1,436	1,495	1,554	1,676	1,804	1,942	2,081	2,221	2,364	2,516	2,674	2,830	2,995	3,172	3,347	3,538	3,714	3,900	4,092	4,288	4,494	4,696	4,908
13	1,092	1,145	1,201	1,258	1,318	1,374	1,431	1,503	1,564	1,628	1,692	1,824	1,964	2,113	2,264	2,416	2,571	2,737	2,907	3,077	3,256	3,448	3,638	3,845	4,036	4,238	4,446	4,659	4,882	5,102	5,332
14	1,183	1,241	1,301	1,363	1,427	1,487	1,549	1,627	1,693	1,762	1,831	1,973	2,125	2,286	2,448	2,612	2,779	2,959	3,142	3,326	3,519	3,726	3,931	4,154	4,360	4,578	4,802	5,032	5,272	5,510	5,758
15	1,275	1,338	1,402	1,469	1,537	1,601	1,668	1,752	1,823	1,897	1,971	2,124	2,288	2,460	2,634	2,810	2,990	3,183	3,379	3,577	3,784	4,006	4,226	4,464	4,686	4,920	5,160	5,407	5,664	5,920	6,186
16	1,368	1,436	1,504	1,576	1,648	1,716	1,788	1,878	1,954	2,033	2,112	2,276	2,452	2,636	2,821	3,009	3,202	3,408	3,617	3,829	4,051	4,288	4,523	4,776	5,014	5,264	5,520	5,784	6,058	6,332	6,616
17	1,462	1,535	1,608	1,684	1,760	1,833	1,910	2,006	2,087	2,171	2,255	2,430	2,617	2,813	3,010	3,210	3,416	3,635	3,857	4,083	4,310	4,571	4,822	5,090	5,344	5,610	5,883	6,164	6,455	6,747	7,049
18	1,557	1,635	1,713	1,793	1,873	1,957	2,033	2,135	2,221	2,310	2,399	2,585	2,784	2,992	3,200	3,412	3,631	3,863	4,099	4,339	4,581	4,856	5,123	5,406	5,676	5,958	6,248	6,546	6,854	7,154	7,484
19	1,653	1,736	1,819	1,903	1,987	2,071	2,157	2,265	2,356	2,450	2,545	2,742	2,952	3,172	3,392	3,616	3,848	4,093	4,342	4,596	4,854	5,143	5,426	5,724	6,010	6,308	6,615	6,930	7,255	7,573	7,921
20	1,749	1,838	1,926	2,014	2,102	2,190	2,282	2,396	2,492	2,591	2,692	2,900	3,122	3,353	3,585	3,821	4,067	4,325	4,587	4,855	5,128	5,432	5,731	6,044	6,346	6,660	6,984	7,316	7,658	7,994	8,360
21	1,846	1,942	2,034	2,126	2,219	2,312	2,408	2,529	2,630	2,734	2,841	3,060	3,293	3,536	3,780	4,028	4,288	4,558	4,834	5,116	5,404	5,723	6,038	6,366	6,684	7,014	7,355	7,704	8,064	8,418	8,802
22	1,946	2,047	2,143	2,239	2,337	2,435	2,535	2,663	2,769	2,878	2,991	3,221	3,466	3,720	3,976	4,237	4,510	4,793	5,083	5,379	5,682	6,016	6,347	6,690	7,024	7,370	7,728	8,094	8,472	8,844	9,248
23	2,047	2,153	2,253	2,353	2,456	2,559	2,663	2,798	2,909	3,024	3,142	3,384	3,640	3,906	4,174	4,448	4,734	5,030	5,334	5,644	5,962	6,311	6,657	7,016	7,366	7,728	8,103	8,486	8,882	9,272	9,696
24	2,149	2,261	2,364	2,468	2,576	2,684	2,792	2,934	3,050	3,171	3,294	3,548	3,816	4,093	4,373	4,660	4,959	5,268	5,596	5,911	6,244	6,608	6,969	7,344	7,710	8,088	8,480	8,880	9,294	9,702	10,146
25	2,251	2,370	2,475	2,583	2,698	2,810	2,922	3,072	3,193	3,320	3,448	3,713	3,993	4,282	4,574	4,874	5,186	5,508	5,840	6,180	6,527	6,907	7,283	7,674	8,056	8,451	8,860	9,277	9,709	10,135	10,598
26	.....	.....	2,587	2,699	2,821	2,936	3,053	3,211	3,337	3,470	3,603	3,880	4,172	4,472	4,776	5,089	5,414	5,750	6,096	6,451	6,812	7,208	7,599	8,006	8,404	8,816	9,242	9,676	10,126	10,570	11,054
27	.....	.....	.....	.....	2,949	3,053	3,184	3,354	3,483	3,621	3,760	4,048	4,352	4,664	4,980	5,306	5,644	5,993	6,353	6,724	7,099	7,511	7,917	8,340	8,754	9,183	9,626	10,077	10,545	11,007	11,512
28	.....	.....	.....	.....	.....	.....	3,316	3,498	3,630	3,773	3,918	4,218	4,533	4,807	5,185	5,525	5,876	6,238	6,612	6,998	7,388	7,816	8,237	8,676	9,106	9,552	10,012	10,480	10,966	11,446	11,973
29	.....	.....	.....	.....	.....	.....	.....	.....	3,774	3,927	4,078	4,389	4,716	5,052	5,392	5,746	6,109	6,485	6,873	7,274	7,679	8,123	8,559	9,014	9,460	9,923	10,400	10,886	11,390	11,888	12,436
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,239	4,560	4,900	5,248	5,601	5,968	6,344	6,734	7,136	7,552	7,972	8,432	8,883	9,354	9,816	10,296	10,790	11,294	11,816	12,334	12,902
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,733	5,086	5,446	5,812	6,192	6,581	6,985	7,401	7,832	8,267	8,742	9,209	9,696	10,174	10,671	11,182	11,704	12,244	12,782	13,370
32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,273	5,645	6,024	6,417	6,819	7,237	7,668	8,114	8,564	9,054	9,537	10,040	10,534	11,048	11,576	12,116	12,674	13,232	13,841
33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,806	6,236	6,644	7,059	7,491	7,937	8,397	8,863	9,378	9,867	10,386	10,897	11,428	11,973	12,531	13,107	13,684	14,314
34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,450	6,871	7,301	7,747	8,208	8,682	9,164	9,694	10,199	10,734	11,262	11,810	12,372	12,948	13,542	14,140	14,790
35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,099	7,543	8,004	8,481	8,969	9,467	10,012	10,533	11,084	11,629	12,194	12,773	13,367	13,979	14,598	15,268
36	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,329	7,786	8,261	8,755	9,258	9,772	10,332	10,869	11,436	11,998	12,580	13,176	13,788	14,418	15,059	15,649
37	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,031	8,520	9,029	9,549	10,079	10,654	11,207	11,790	12,369	12,968	13,582	14,212	14,860	15,522	16,032
38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,781	9,306	9,840	10,388	10,978	11,547	12,146	12,742	13,358	13,990	14,638	15,306	15,988	16,518
39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,684	10,133	10,697	11,304	11,889	12,504	13,117	13,750	14,400	15,066	15,754	16,456	16,996
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,428	11,007	11,630	12,233	12,864	13,488	14,144	14,812	15,496	16,204	16,927	17,487
41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,319	11,958	12,577	13,227	13,868	14,541	15,227	15,929	16,656	17,400	17,980
42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12,288	12,923	13,590	14,250	14,940	15,664	16,364	17,110	17,876	18,476
43	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,271	13,955	14,632	15,341	16,063	16,801	17,566	18,354	18,974
44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14,322	15,016	15,712	16,484	17,240	18,024	18,835	19,475
45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,402	16,145	16,905	17,680	18,485	19,318	19,978
46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16,550	17,349	18,122	18,948	19,802	20,484
47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16,958	17,775	18,566	19,411	20,290	20,992
48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18,203	19,014	19,817	20,776	21,502
49	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,469	20,285	21,264	22,015
50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20,755	21,655	22,530
51	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22,148	23,047
52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23,567

TABLE SHOWING THE CAPACITY OF LADLES AT EACH INCH OF THEIR DEPTH, FOR LADLES FROM 1,800 TO 25,000 POUNDS CAPACITY. TABLE IS BASED ON A TAPER OF 1½ INCHES PER FOOT

each metal, and is also different for linear, surface and cubical expansion.

This coefficient really represents the percentage which any body of metal expands when the temperature is raised 1 degree Fahr.

The co-efficient for the cubical expansion of cast iron is 0.00001850, and its pouring temperature is about 2,760 degrees Fahr. Assuming normal temperature to be 60 degrees then the actual change in temperature would be 2,760 degrees — 60 degrees = 2,700 degrees.

The formula for the cubical expansion of metals is as follows:

$V^2 = V\ C_3\ T$ in which V = increase of volume of body.

V^1 = Original volume of body.

C_3 = Co-efficient of cubical expansion

T = Increase in temperature in degrees Fahr.

Now if we assume our original volume to be 100 inches, then substituting the values in the above formula—V = 100 × 0.00001850 × 2,700 = 4.995 inches, or practically five inches, and five inches is 5 per cent of 100 inches, therefore, a body of cast iron heated from 60 degrees to 2,760 degrees Fahr. expands 5 per cent of its original volume, and so we find that a ladle will only carry 95 per cent of its figured capacity.

This was an unexpected revelation to the writer, for in a ladle of 12,000 pounds figured capacity, the difference would be 5 per cent of 12,000 pounds or 600 pounds, an amount which if missing in a casting would be a serious item.

As previously stated this expansion caused the writer considerable annoyance as it was overlooked when the first tables were constructed, and it was only after these tables were found to give results which were too high and, therefore, unreliable, that the necessity of considering this important factor was discovered, and as this factor had to be considered at each inch in the ladle's depth, the writer decided to incorporate it in the constant 0.206 which was formed as previously shown.

Rule for Ladle Capacities.

As stated above this expansion amounts to 5 per cent of the original volume of the metal when the temperature is increased 2,700 degrees, and as our old constant was based on stationary temperature it is evident that the new constant will be 95 per cent of 0.206 or 0.19570, practically 0.196. By the use of this new constant we are enabled to construct the following rule for ladle capacities:

Multiply the square of the average diameter in inches by the constant .196, and multiply the quotient by the depth in inches.

This gives us the capacity of the ladle in pounds. For example: Wanted, the capacity of a ladle 32 inches in diameter at the top, 28 inches diameter at the bottom, 32 inches deep, the average diameter would then be

$$\frac{28 + 32}{2} = 30 \text{ inches}$$

and the capacity of one inch would be 30 × 30 × 0.196 = 176.4 pounds, and for 32 inches would be 32 × 176.4 = 5,644 pounds total capacity.

TABLE SHOWING THE CAPACITY OF LADLES AT EACH INCH OF THEIR DEPTH, FOR LADLES FROM 1,000 TO 25,000 POUNDS CAPACITY

DIAMETER OF LADLE AT THE BOTTOM IN INCHES.

Iron in ladle, inches.	46	47	48	49	50	51	52	53	54	55
1	415	433	452	471	491	510	531	551	572	594
2	832	868	906	944	984	1,023	1,064	1,104	1,146	1,191
3	1,257	1,305	1,362	1,420	1,480	1,538	1,600	1,660	1,723	1,791
4	1,672	1,744	1,820	1,898	1,978	2,056	2,138	2,218	2,302	2,394
5	2,096	2,186	2,281	2,379	2,479	2,576	2.679	2,779	2,884	2,999
6	2,522	2,632	2,744	2,862	2,982	3,099	3,222	3,343	3,469	3,606
7	2,950	3,080	3,210	3,348	3,488	3,625	3,768	3,909	4,057	4,216
8	3,380	3,530	3,678	3,836	3,996	4,153	4,316	4,478	4,648	4,829
9	3,813	3,982	4,149	4,327	4,506	4,684	4,867	5,050	5,242	5,445
10	4,248	4,436	4,622	4,820	5,019	5,217	5,420	5,624	5,839	6,063
11	4,685	4,892	5,098	5,316	5,534	5,753	5,976	6,201	6,439	6,684
12	5,124	5,350	5,576	5,814	6,052	6,291	6,534	6,780	7,040	7,308
13	5,566	5,811	6,057	6,315	6,572	6,832	7,095	7,362	7,647	7,935
14	6,012	6,274	6,540	6,818	7,095	7,375	7,659	7,947	8,254	8,564
15	6,460	6,740	7,026	7,324	7,621	7,921	8,225	8,535	8,864	9,196
16	6,910	7,208	7,514	7,832	8,149	8,469	8,784	9,126	9,477	9,831
17	7,362	7,679	8,005	8,342	8,680	9,020	9,356	9,720	10,093	10,469
18	7,816	8,152	8,498	8,855	9,213	9,533	9,930	10,317	10,711	11,109
19	8,272	8,628	8,994	9,370	9,749	10,129	10,500	10,917	11,332	11,752
20	8,730	9,106	9,492	9,888	10,287	10,687	11,086	11,520	11,956	12,398
21	9,191	9,587	9,993	10,408	10,828	11,248	11,668	12,125	12,583	13,047
22	9,654	10,070	10,496	10,931	11,371	11,812	12,253	12,732	13,212	13,698
23	10,120	10,556	11,002	11,457	11,917	12,378	12,841	13,342	13,844	14,352
24	10,588	11,044	11,510	11,985	12,465	12,947	13,432	13,955	14,479	15,009
25	11,059	11,535	12,020	12,516	13,016	13,519	14,026	14,571	15,117	15,669
26	11,532	12,028	12,533	13,049	13,569	14,093	14,623	15,189	15,757	16,331
27	12,008	12,524	13,048	13,585	14,125	14,670	15,223	15,810	16,400	16,996
28	12,486	13,022	13,566	14,123	14,683	15,249	15,826	16,434	17,046	17,664
29	12,967	13,523	14,086	14,664	15,244	15,831	16,431	17,051	17,695	18,335
30	13,450	14,026	14,609	15,207	15,808	16,416	17,038	17,680	18,346	19,009
31	13,936	14,532	15,135	15,753	16.374	17,004	17,648	18,312	19,000	19,686
32	14,424	15,040	15,663	16,301	16,943	17,595	18,261	18,947	19,657	20,366
33	14,915	15,550	16,194	16,852	17,515	18,189	18,877	19,585	20,317	21,049
34	15,408	16,063	16,727	17,405	18,089	18,786	19,495	20,225	20,979	21,734
35	15,904	16,578	17,263	17,961	18,666	19,386	20,116	20,868	21,644	22,422
36	16,402	17,096	17,801	18,519	19,245	19,989	20,740	21,514	22,312	23,113
37	16,903	17,616	18,342	19,080	19,827	20,594	21,367	22,163	22,983	23,807
38	17,406	18,139	18,885	19,644	20,412	21,201	21,996	22,814	23,657	24,504
39	17,912	18,665	19,431	20,210	21,000	21,811	22,628	23,468	24,334	25,204
40	18,420	19,193	19,999	20,779	21,591	22,424	23,263	24,125	25,014	25,907
41	18,930	19,724	20,530	21,351	22,185	23,040	23,901	24,785	25,697	26,613
42	19,443	20,257	21,083	21,925	22,782	23,650	24,541	25,447	26,382	27,322
43	19,958	20,793	21,639	22,402	23,382	24,271	25,184	26,115	27,070	28,034
44	20,476	21,331	22,197	22,981	23,985	24,895	25,830	26,786	27,761	28,749
45	20,946	21,872	22,758	23,563	24,590	25,522	26,479	27,460	28,455	29,467
46	21,519	22,415	23,322	24,148	25,197	26,151	27,130	28,137	29,152	30,188
47	22,045	22,961	23,888	24,736	25,807	26,783	27,784	28,817	29,852	30,912
48	22,573	23,509	24,557	25,327	26,420	27,418	28,441	29,500	30,555	31,639
49	23,104	24,060	25,129	25,921	27,036	28,056	29,101	30,185	31,261	32,369
50	23,637	24,613	25,703	26,518	27,654	28,696	29,763	30,873	31,920	33,102
51	24,173	25,169	26,280	27,118	28,275	29,339	30,428	31,564	32,682	33,838
52	24,711	25,727	26,859	27,721	28,899	29,983	31,096	32,208	33,397	34,577
53	25,252	26,288	27,441	28,326	29,526	30,634	31,767	32,905	34,115	35,319
54	25,795	26,852	28,032	28,923	30,155	31,283	32,441	33,605	34,836	36,064
55	.....	27,418	28,626	29,533	30,787	31,939	33,118	34,308	35,560	36,812
56	.....	27,987	29,223	30,146	31,422	32,596	33,798	35,014	36,287	37,563
57	.....	.....	29,823	30,762	32,050	33,256	34,481	35,723	37,017	38,318
58	.....	.....	30,426	31,380	32,690	33,918	35,166	36,435	37,750	39,076
59	.....	.....	.....	32,001	33,333	34,583	35,854	37,150	38,486	39,838
60	.....	.....	.....	32,625	33,979	35,251	36,545	37,868	39,225	40,602
61	.....	.....	.....	.....	34,628	35,922	37,244	38,589	39,967	41,369
62	.....	.....	.....	.....	35,279	36,596	37,941	39,313	40,712	42,139
63	.....	.....	.....	.....	.....	37,273	38,641	40,040	41,460	42,912
64	.....	.....	.....	.....	.....	37,953	39.343	40,770	42,211	43,688
65	.....	.....	.....	.....	.....	.....	40,049	41,507	42,966	44,467
66	.....	.....	.....	.....	.....	.....	.....	42,312	43,724	45,249
67	.....	.....	.....	.....	.....	.....	.....	43,120	44,485	46,034
68	.....	.....	.....	.....	.....	.....	.....	.....	45,246	46,832
69	.....	.....	.....	.....	.....	.....	.....	.....	46,011	47,632
70	.....	.....	.....	.....	.....	.....	.....	.....	.....	48,438

TABLE SHOWING THE CAPACITY OF LADLES AT EACH INCH OF THEIR DEPTH. FOR LADLES FROM 25,000 TO 45,000 POUNDS CAPACITY

Ladle Taper a Factor.

This method can be applied only to the total capacity of a ladle, for as previously stated the taper in a ladle makes each inch a separate problem, and the only way to correctly obtain the capacity of a ladle at varying depths is to figure each inch separately, and add the results successively. To illustrate, take the example above, and at the bottom the

diameter is only 28 inches and 28 × 28 × 0.196 = 153.6 pounds, which is the capacity of one inch at the bottom of the above sized ladle, and as the top diameter is 32 inches, then 32 × 32 × 0.196 = 200.7 pounds, which is the capacity of one inch at the top of the same ladle. As this shows, there is a difference in capacity of 47.1 pounds per inch, between the bottom and top of this sized ladle, and although this difference is less at each intervening inch, yet this serves to show how great the difference would be between the capacity of any number of inches at the bottom and the same number of inches at the top.

Use of the Tables.

The accompanying tables are based on a taper in all the different sized ladles of 1½ inches to the foot or ⅛ of an inch to the inch. However, a ladle might differ from this taper considerably without materially affecting the results.

The dimensions given in the table are all in inches, and the sizes of ladles are based on their diameter inside the lining at the bottom. The lining of a ladle thickens with use, and when this thickening is sufficient to affect the results new measurements should be taken, and the column in the table corresponding to its new diameter must be used. Allowance must also be made if the bottom thickens.

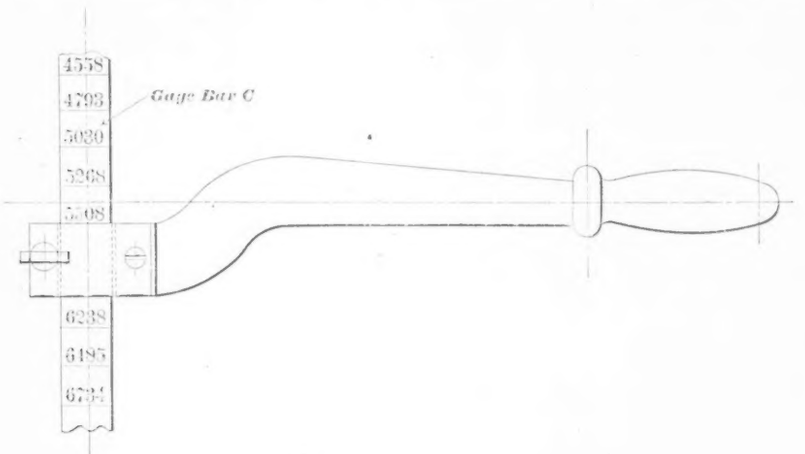


FIG. 2—GAGE BAR FOR MEASURING THE AMOUNT OF IRON IN LADLES

Gage for Measuring Iron in Ladles.

The gage which is used in connection with this table, and the method of using same is shown in sketch, Fig. 1. The gage consists of a holder as shown in Fig. 2, and a bar of iron to fit the same with graduations one inch apart, each graduation being stamped with the capacity of the ladle at the corresponding depth. The sketch shows the gage for our 8,000-pound ladle which is 32 inches in diameter inside the lining at the bottom, and is 38 inches deep. As will be seen the same holder will do for all ladies, but a different bar should be provided for each ladle. This, however, is not absolutely necessary, for if a bar is provided long enough to suit the deepest ladle it can be used on the smaller sizes as well by obtaining from the table the number of inches of iron it is desired to take, and setting the gage by measurement to suit the same. Or, this may be varied by using a piece of iron bent at right angles and cut at the length which gives the desired amount in the ladle, as shown in the sketch, the length of the projecting piece will be equal to the depth of ladle minus the number of inches of iron it is desired to take. The sketch makes the method of using very plain. Any shape bar will do for a gage bar, but a flat bar about 1 x ⅛ inch is preferred by the writer, and the sketch shows this kind of a bar in holder.

Use of Gage Bar.

The sketch also shows the holder set at 5,508 pounds of iron. If it is desired to gage this same amount of iron in the same size ladle without using this form of gage, all that is necessary is to turn to the table and find the column for a ladle 32 inches in diameter at the bottom. Then find in this column the figure corresponding to the amount of iron it is desired to take, in this case 5,508 pounds, and look for the corresponding figure in the column denoting how many inches must be taken, which in this case is 25 inches. This depth can then be marked on the inside of the ladle, or can be gaged by any of the methods heretofore described.

However, the gage as shown in the sketch is of so simple a construction that any shop containing ordinary hand tools can make one at very little cost and they afford by far the most convenient method of gaging. The construction is shown very plainly in Fig. 2. The numbers on the gage bars are taken from the accompanying table and stamped on the bar at the proper graduation by means of steel stamps. The sizes of the ladles are determined at the bottom and gages are stamped with the numbers in a corresponding column of the table. The gage bars can be changed in the holder and also adjusted and held in proper position by means of the thumb screw which is shown.

By means of one of these holders and bars to suit the different ladles which may be in any foundry it is possible to gage the iron in the ladles with absolute certainty, and thus reduce the chances of pouring short or of having to pig a large quantity of surplus iron.

BIRMINGHAM BRANCH OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

The monthly meeting of the Birmingham branch of the British Foundrymen's Association was held at the Technical School, Birmingham, Jan. 25. A. H. Hiorns delivered a lecture on "The Effect of Carbon on Iron" and dealt exhaustively with the important part played by this element in iron, pointing out that it was practically impossible to obtain a sample of iron absolutely free from carbon, while there is no method for removing carbon from solid iron without destroying the iron. The carbon, however, is changed into different states by heat treatment.

The percentage of carbon is the essential difference between steel and cast iron. Pure cast iron is simply a more highly carbureted form of steel. By means of a number of diagrams the lecturer traced the result of the condition of the graphitic flakes upon the strength of the metal. Mottled cast iron is a mixture of gray and white iron in which either the graphite or the combined carbon might predominate and the metal is roughly intermediate in properties between the softness of the gray and the hardness of the white iron.

Some attention was next given to temper carbon, which appeared to be an essential constituent of all very strong irons. The lecture emphasized the importance of an exact knowledge of the temperature at which the combined car-

bon is set free and the softening effect occurs.

The high tensile strength of malleable castings is due to the smallness of the carbon particles, the cohesion of which might be increased by mechanical work, and carbide of iron when present in moderate quantity, say 1 per cent, increases the tensile strength.

Dealing next with diamond carbon the speaker said there appeared to be a close connection between graphite and the diamond, which was simply another form of carbon, and the most successful attempts to form artificial diamonds had been made with cast iron by making use of the pressure resulting from the increase of volume undergone by a mass of molten iron as it passes from the liquid to the solid state.

The carbon particles of high density produced by plunging carbon-saturated iron, at a high temperature into a bath of cold water appear to be real diamonds. If diamond carbon exists in hardened steel and white cast iron, the great hardness of those metals might be attributed to its presence.

Some attention was devoted by the speaker to the effect of chills on cast iron. In regard to the metal containing 3 per cent total carbon the best effects in the depth of chill are obtained with 1 per cent or less of silicon with less than ½ per cent phosphorus and about 1½ per cent manganese. High silicon is conducive to more rapid chilling, and aluminum reduces the depth of the chill. A little phosphorus is useful in chilled rolls to be used for cold rolling, but for hot work even a little phosphorus might prove a great evil in causing the metal to break more readily.

R. Buchanan, the chairman, in opening the discussion said it had been a great pleasure to him to hear the carbon question discussed in its different phases. It was a matter of vital importance to foundrymen to know the position, conduct and condition of carbon. If they could only know clearly what was happening in the casting in regard to carbon it would go a long way towards completely regulating the product and controlling the results. They would have to include in their knowledge the influence of other elements on the carbon, and then the product might be satisfactory. In the interesting discussion which had been in progress lately Sir William Crooks had pointed out that the diamond found in its natural state in South Africa was always in mud of a highly volcanic character, which indicated that the carbon gases had been subjected to temperatures of which we know absolutely nothing, even with the electric furnace. The two conditions necessary include a very high temperature and an intense pressure.

LARGE CORES WITHOUT ARBORS

Molding a Large Roll With a Sectional Core Consisting of Eight Parts

BY PAUL R. RAMP

THE piece of work I will describe is a large roll used in the manufacture of lard. This casting measures 4 feet in diameter, is 9 feet long in the body or drum, and about 13 feet over all, which includes a journal on each end. The metal in the body of the casting is 1¼ inches thick. One end of the casting is closed and the other end has three small openings, 4 inches in diameter.

These small openings must provide the means of escape for the gas created in the cores while the mold is being filled with molten metal; also an opening to take out the sand and rods after the mold has been poured. This mold is made and cast in an upright position as shown in Fig. 1, which is a cross section of the mold showing the details of the work.

The Pattern.

The mold is made in dry sand. The patterns consist of a plain ring 48 inches in diameter and 24 inches deep, and one end plate pattern with journal piece attached. The end plate pattern is used to form both the top and bottom end by lifting off the cheeks, after they have been rammed up, drawing the same out of the drag, and placing it on top of the cheek, and ramming up the coke.

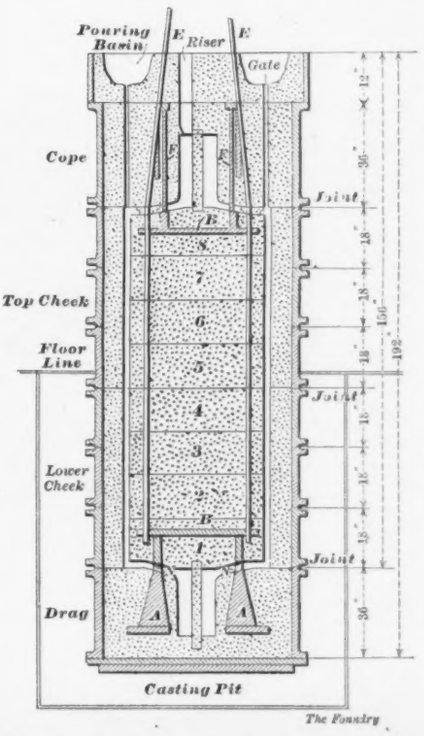


FIG. 1—SECTIONAL VIEW OF ROLL MOLD

In using the ring part of the pattern, it is placed on the drag after the same has been rammed up and rolled over, and the first section of the lower cheek placed in position. The outside of this ring is rammed up to the top, when the ring is drawn up about 8 inches, and another ramming made, followed by the ring being drawn up again and rammed. This method of ramming is continued until the upper joint of the top cheek has been reached. It is at this stage that the cheeks are lifted off, as described before, to permit the end plate pattern being drawn out of the drag.

The Mold.

Fig. 1 shows a cross section of this mold ready for casting. The anchor supports that are rammed up in the drag are shown at A, and NN are the anchors that support the large cores. These anchors are made of soft steel with a coarse thread cut in them to prevent a leak at this point. B is an arbor used in the bottom and top cores. This arbor is provided with prongs that extend to the surface of the cores, and form an iron to iron bearing for the anchors.

The Cores.

The large core that forms the center of this casting is made in eight pieces,

Editors' Note.—This article was awarded fourth prize in the contest conducted by THE FOUNDRY.

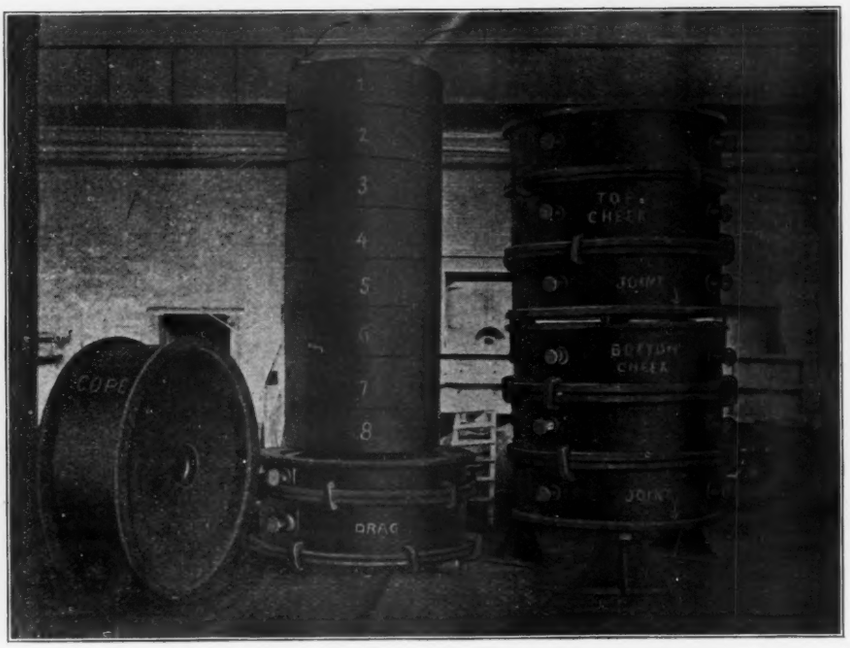


FIG. 2—CORES FOR ROLL MOLD AND COPE, CHEEKS AND DRAG

as it would be impossible to make this core in one piece and get the arbors necessary to hold it in shape out of the small openings in the end.

This method makes it necessary to exercise great care in properly joining each core and connecting the vents, as the gas from the bottom core must pass through the seven cores above it, and the gas from the core next to the bottom must pass through the six cores above it, and so on until the vent passage reaches the top core, where it is taken off through the small openings.

The result of any carelessness on the part of the molder in not carefully connecting these vents, or, allowing the iron to force its way into the joints between these cores, can readily be imagined. For this reason the cores are placed on the drag, lined up, and the joints carefully filled with core sand, and thoroughly dried. Fig. 2 shows cores Nos. 8, 7, 6, 5 and 4, with the joints closed up, and the cores Nos. 3, 2 and 1, ready for the same treatment. This also gives a good view of the upper and lower cheeks, and the cope at MM. The projections that form the three small openings can also be seen.

Cores Nos. 1, 2 and 3 are not placed in position until after the lower cheek has been closed on, and the mold placed in the casting pit.

Referring again to Fig. 1, FF represent the top anchors, six in number, made of ⅞-inch wrought iron, and securely wedged down under a flange in the cope, provided for that purpose. There are no anchors on the sides, as they are not permitted in the casting which is shown in Fig. 3.

The Casting.

These castings must withstand 200 pounds pressure per square inch, and are made from a special mixture of iron. The mold is poured through 12 small gates that lead to the pouring basin direct to the mold. A riser is used on the end of the top journal, but is not essential as the expansion of the cores takes up all the shrinkage in the iron.

The fact that this mold affords such a limited space for all the gas generated to escape in so large a core, and that this limited space makes it necessary to devise a method of molding cores that will not require large arbors to hold them together in order to resist the enormous lifting pressure when the mold is filled,—which, in this case, is about 34 tons—and that the numerous core joints must be carefully taken care of, the high pressure specified requiring a good iron and a perfect casting, make this job an exceedingly interesting one.

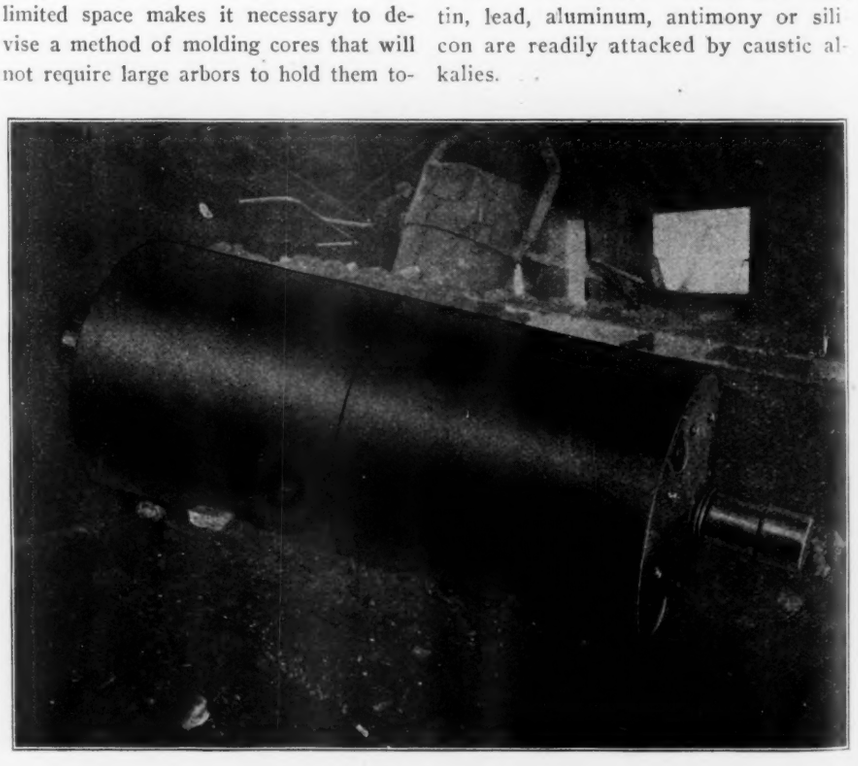


FIG. 3—THE ROLL CASTING

ALLOY FOR IRON AND STEEL CASTINGS.

Bubbles and blow-holes in ingots of cast steel are chiefly due to the presence of three gases, oxide of carbon, hydrogen and nitrogen. By adding a small quantity of aluminum at the moment of casting, the oxide of carbon is removed. The hydrogen and nitrogen may be removed by employing such metals as calcium, barium, strontium and lithium. It is preferable to employ these metals alloyed with aluminum so that all the gases are simultaneously removed. An alloy of aluminum and calcium, or of aluminum and barium, etc., may thus be employed. A patent covering the manufacture of these alloys has recently been granted. Aluminum-calcium and other alloys containing up to 95 per cent of calcium can be made by this process.

ALKALI-PROOF METAL.

Alkali-proof metal is cast iron containing from 5 to 10 per cent of nickel. All alloys containing zinc, tin, lead, aluminum, antimony or silicon are readily attacked by caustic alkalies.

TESTS OF VANADIUM IN CAST IRON

This Series of Tests Show that the Breaking Strength of Gray Iron is Increased by the Use of this Alloy

BY RICHARD MOLDENKE

FOR A NUMBER of years admirable reports on alloys have come from Europe, and among them one would occasionally see mention of vanadium and its remarkable effect on steel. The practical steel maker, however, knowing the high price of this rare metal could only regret that vanadium had no commercial application.

Since the discovery recently of enormous deposits of vanadium, more particularly those in Colorado, matters have assumed a different shape. Prof. Hildebrand, of the U. S. Geological Survey, first located a deposit of vanadiferous sandstone in that state, and this is now being worked extensively, and the ferro-alloy is made in this country. The supply of vanadium is practically unlimited.

The properties of vanadium steel are as follows: The elastic limit is increased without an impairment of the ductility of the steel. That is, an exceedingly strong steel is obtained with its softness still remaining. Coupled with these most valuable properties is another, and that is the extreme resistance to deterioration when the metal is subjected to severe and continued strains in service. It is non-fatiguing, and therefore an ideal railroad and rolling mill metal.

It is but natural that attention should be drawn to this new candidate for metallurgic favor for foundry use. The very first casting which might be benefited is the car wheel, next, the various kinds of rolls; then alkali pots, pump parts, etc.

To learn something of the effects of vanadium on cast iron, a series of tests were conducted, using melted scrap car wheels for white iron, and a good machinery pig iron for a variety of gray iron. A ferro-vanadium carrying high carbon was selected because it melted at a lower temperature, and would also be cheaper for the foundryman. Varying proportions were added to the ladle full of molten metal, first in lump form, and as this did not give satisfaction with the small quantities of iron used at a time, the alloy was powdered before using.

Inasmuch as vanadium, besides being a great strengthener, is also a powerful deoxidizing agent, and the increase in strength obtained by its use might be attributed to the purification of the iron only, a further series of tests were included in which the ladle was first treated with 80 per cent ferro-manganese in sufficient quantity to add 0.5 per cent of manganese, and then the ferro-vanadium. In order to obtain some light on the deoxidizing power of vanadium, tests were also made with burnt metal, the results of which are given in the accompanying tables.

The test bars were of the regulation kind, as prescribed by the American Society for Testing Materials, namely, 1¼ inch round, cast on end, in dried molds. At first the molds were rammed up in the usual way in snap-flasks, and the shells arranged to allow setting up and pouring the molds on end. The slightly varying diameters of the bars resulting, however, brought about a better method. Fairly heavy perforated metal sheets were cut to size and riveted up. A bottom was provided in similar manner. A little sand was rammed in the bottom, the pattern placed, rammed up, and the pattern was withdrawn by a spiral upward movement. The molds were then baked and afterwards poured. Striking the mold would drop the sand and test bar out, and another mold could then be made. Some 40 of these perforated flasks were rammed up and dried for every run.

Table I.

BURNT IRON—GRAY. BURNT GRATE BARS, STOVE IRON, ETC.

No vanadium added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
1	1,500	0.105	29,410
2	1,380	0.100	27,080
3	1,060	0.070	20,720
4	1,020	0.100	19,020
5	1,600	0.085	31,290
Average	1,310	0.090	25,500

Analysis of No. 2, per cent.	
Silicon	2.13
Sulphur	0.094
Phosphorus	0.638
Manganese	0.35

0.05 per cent vanadium added (lump).

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
6	2,430	0.100	47,550
7	2,200	0.100	43,030
8	2,020	0.100	39,570
Average	2,220	0.100	43,380

Analysis of No. 7, per cent.	
Silicon	2.03
Sulphur	0.095
Manganese	0.37

Table II.

BURNT IRON, WHITE.

No vanadium added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
9	1,400	0.045	27,480
10	1,480	0.050	28,870
11	1,440	0.050	28,170
Average	1,440	0.050.	28,170

Analysis of No. 11, per cent.	
Silicon	0.41
Sulphur	0.146
Phosphorus	0.423
Manganese	0.43

0.50 per cent manganese and 0.05 per cent vanadium (lump) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
12	1,740	0.060	34,080
13	1,650	0.050	32,300
14	1,940	0.050	38,070
15	1,940	0.050	38,070
16	1,910	0.060	37,380
17	1,680	0.050	32,840
18	1,880	0.050	36,830
19	2,140	0.060	41,780
20	1,940	0.055	37,930
21	1,780	0.065	34,770
22	2,170	0.050	42,470
23	2,160	0.060	42,190
Average	1,910	0.055	37,400

Analysis of No. 16, per cent.	
Manganese	0.65

The cupola was especially made for the tests, 22 inches inside the lining, and built into a corner tower of the writer's castle. The tuyeres were pretty close to the bottom, as but little iron was to be held at a time.

A Sturtevant fan supplied the air,

power being obtained from a small gasoline engine. The cupola was but 3 feet high above the spout, and was charged without difficulty. When the asbestos charging door was lowered, the draft was very strong, as the flue in the tower went to the battlement forming the roof of the castle, some 30 feet high at that point. This flue was 3 feet in diameter, in the tower of solid concrete, and thus made an excellent cupola stack. The coke bed was brought to red heat quickly, and the iron came out very hot, especally as a high coke ratio is necessary with a small cupola.

The test bars, dumped when cold, were only brushed and then broken transversely on a 5,000-pound Riehle testing machine.

The test bars were carefully calipered, results of tests tabulated, and the modulus of rupture calculated. As there were quite a lot of tests, and many of the bars varied slightly in diameter from the standard, making it difficult to compare effects by glancing over the tables, the breaking weights were all recalculated from the modulus of rupture back to the standard 1¼ inch diameter test bar. This, while not correct in its strictest sense, as cast iron is not homogeneous and does not follow the rules applicable to steel—is nevertheless perfectly reliable for a very fair comparison in showing the general effects of the alloy addition.

The analyses were for the most part made on bars in which the powdered alloy was used, as these tests were most satisfactory. All tests, however, are given, as they seem to confirm the belief that the addition to the strength of the metal is a well founded one. The vanadium alloy used contained: Vanadium, 14.67 per cent; carbon, 6.36 per cent; silicon, 0.18 per cent.

While the vanadium content is comparatively low, this is a very good alloy for foundry purposes, as cast iron is already high in carbon, and the silicon is too small to cut an appreciable figure in the results.

While the attempt was made to get as nearly 0.05, 0.10 and 0.15 per cent vanadium into the ladles of metal as possible, the analyses show that for the bars selected (as nearly the average for strength as possible) as much as two or three times actually remained after casting. This is due first to the impossibility of accurately weighing the alloy in the small space of time available. Then, with the small quantities tried, the chances for irregular distribution were very great. A foundry with five or ten-ton ladles would

Table III.

MACHINERY IRON, GRAY. MELTED PIG IRON—NO SCRAP.

No vanadium added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
24	1,980	0.095	38,670
25	2,210	0.100	43,220
26	2,230	0.080	43,550
27	1,660	0.120	32,440
28	1,820	0.140	35,540
Average	1,980	0.105	38,680

Analysis of No. 24, per cent.

Silicon	2.72
Sulphur	0.065
Phosphorus	0.668
Manganese	0.54

0.05 per cent vanadium (lump) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
29	1,970	0.120	38,450
30	2,360	0.110	46,150
31	1,880	0.115	36,850
32	1,960	0.090	38,330
33	2,160	0.090	42,240
Average	2,070	0.105	40,410

0.10 per cent vanadium (lump) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
34	2,180	0.120	42,550
35	2,150	0.115	42,080
36	1,730	0.105	33,930
37	1,930	0.110	37,820
38	1,830	0.115	35,810
39	1,990	0.120	38,950
40	1,670	0.135	32,640
41	2,420	0.140	48,380
42	1,900	0.125	37,100
43	2,550	0.100	42,470
44	2,570	0.130	50,250
45	2,280	0.120	44,670
46	2,850	0.110	55,640
47	1,960	0.105	38,250
48	2,050	0.105	40,180
49	2,520	0.105	49,290
50	2,600	0.100	50,850
51	2,280	0.100	44,670
52	2,250	0.115	43,980
Average	2,200	0.115	42,600

0.15 per cent vanadium (lump) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
53	2,800	0.140	54,800
54	2,940	0.115	57,410
55	2,680	0.125	52,330
56	2,560	0.140	50,070
Average	2,740	0.130	53,750

0.50 per cent manganese and no vanadium added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
57	2,070	0.100	40,400
58	1,910	0.100	37,360
59	1,920	0.100	37,470
Average	1,970	0.100	38,410

0.05 per cent vanadium (ground) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
60	1,940	0.100	37,930
61	1,980	0.100	38,760
62	2,110	0.100	41,230
63	1,900	0.095	37,110
64	1,970	0.100	38,470
Average	1,980	0.100	38,700

Analysis of No. 61, per cent.

Manganese	0.54
Vanadium	0.33

0.50 per cent manganese and 0.05 per cent vanadium (ground) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
65	2,210	0.110	43,290
66	2,120	0.100	41,500
67	2,110	0.100	41,230
68	2,100	0.100	41,090
Average	2,130	0.100	41,780

Analysis of No. 66, per cent.

Manganese	0.66
Vanadium	0.25

0.10 per cent vanadium (ground) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
69	2,240	0 090	43,830
70	2,400	0.095	46,810
71	2,500	0.095	48,770
72	2,410	0.090	47,140
73	2,310	0.090	45,080
Average	2,372	0.090	46,320

Analysis of No. 70, per cent.

Manganese	0.59
Vanadium	0.36

0.50 per cent manganese and 0.10 per cent vanadium (ground) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
74	2,440	0.110	47,760
75	2,520	0.120	49,340
76	2,640	0.120	51,670
Average	2,530	0.120	49,590

Analysis of No. 75, per cent.

Manganese	0.59
Vanadium	0.25

0.15 per cent vanadium (ground) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
77	2,320	0.100	45,350
78	2,330	0.100	45,490
79	2,250	0.100	43,980
80	2,450	0.100	47,960
81	2,430	0.100	47,550
Average	2,360	0.100	46,070

Analysis of No. 78, per cent.

Manganese	0.56
Vanadium	0.27

Table IV.

REMELTED CAR WHEELS, WHITE. NO PIG IRON.
No vanadium added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
82	1,420	0.040	27,760
83	1,550	0.050	30,220
84	1,470	0.045	28,720
85	1,710	0.050	33,420
86	1,200	0.050	20,390
Average	1,470	0.050	28,100

Analysis of No.	82. Per ct.	85. Per ct.
Silicon	0.60	0.53
Sulphur	0.122	0.138
Phosphorus	0.399	0.374
Manganese	0.38	0.44

0.05 per cent vanadium (lump) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
87	2,750	0.050	53,750
88	1,880	0.050	36,730
89	2,000	0.050	39,030
90	1,960	0.055	38,340
91	2,350	0.050	39,990
Average	2,190	0.050	41,570

0.15 per cent vanadium (lump) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
99	2,100	0.075	41,090
100	2,300	0.050	44,810
101	2,570	0.080	50,300
102	2,360	0.050	46,180
103	2,020	0.055	39,440
104	2,410	0.050	47,140
105	2,130	0.070	23,570
106	2,220	0.060	43,290
Average	2,264	0.060	44,480

0.50 per cent manganese and no vanadium added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
107	3,060	0.070	59,860
108	2,700	0.070	52,840
109	2,590	0.070	50,560
110	2,810	0.075	55,030
Average	2,790	0.070	54,570

0.05 per cent vanadium (ground) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
111	3,030	0.060	59,260
112	3,010	0.065	58,860
113	3,020	0.060	59,070
114	2,950	0.060	57,690
115	3,040	0.065	59,460
116	3,060	0.060	59,850
Average	3,020	0.060	59,030

Analysis of No. 113,	per cent.
Silicon	0.45
Sulphur	0.096
Phosphorus	0.423
Manganese	0.40
Vanadium	0.36

0.50 per cent manganese and 0.05 per cent vanadium (ground) added.

	Break at, lbs.	Deflection, inches.	Modulus of rupture.
117	2,980	0.080	58,270
118	2,950	0.080	57,720
119	3,020	0.090	59,090
120	3,090	0.090	60,470
121	2,770	0.075	54,280
122	2,990	0.095	58,410
Aevrage	2,970	0.090	58,040

Analysis of No. 117,	per cent.
Silicon	0.66
Sulphur	0.110
Phosphorus	0.591
Manganese	1.15
Vanadium	0.25

0.10 per cent vanadium (ground) added.

	Broke at, lbs.	Deflection, inches.	Modulus of rupture.
123	2,870	0.060	56,130
124	2,640	0.050	51,630
125	2,910	0.060	56,910
Average	2,800	0.055	54,890

Analysis of No. 123,	per cent.
Silicon	0.45
Sulphur	0.119
Phosphorus	0.414
Manganese	0.50
Vanadium	0.31

0.050 per cent manganese and 0.10 per cent vanadium (ground) added.

	Break at, lbs.	Deflection, inches.	Modulus of rupture.
126	2,950	0.090	57,720
127	3,060	0.100	59,780
128	2,970	0.100	57,990
129	3,130	0.080	61,160
Average	3,030	0.090	59,220

Analysis of No. 128,	per cent.
Silicon	0.53
Surphur	0.084
Phosphorus	0.431
Manganese	0.74
Vanadium	0.27

0.15 per cent vanadium (ground) added.

	Break at, lbs.	Deflection, inches.	Modulus of rupture.
130	3,460	0.075	67,670
131	2,700	0.065	52,800
132	2,570	0.060	50,260
133	3,040	0.070	59,310
134	3,250	0.075	63,560
135	2,700	0.060	52,800
Average	2,950	0.070	59,230

Analysis of No. 133,	per cent.
Silicon	0.42
Sulphur	0.112
Phosphorus	0.417
Manganese	0.40
Vanadium	0.45

0.50 per cent manganese and 0.15 per cent vanadium (ground) added.

	Break at, lbs.	Deflection, inches.	Modulus of rupture.
136	4,020	0.090	78,620
137	3,940	0.100	77,050
138	3,960	0.080	77,440
139	3,860	0.080	75,490
140	3,740	0.120	73,070
141	4,000	0.100	78,230
Average	3,920	0.095	76,650

Analysis of No. 137,	per cent.
Silicon	0.50
Sulphur	0.081
Phosphorus	0.374
Manganese	0.54
Vanadium	0.22

give a better opportunity. Finally, there is the uncertainty of how much or little vanadium is oxidized. The very best results with both manganese and vanadium, show very little of the latter remaining.

The results, however, are sufficient to strongly recommend the new alloy to the consideration of foundrymen. If but a part of the resistance to deterioration found by adding vanadium to steel should be proven by service trials to exist in cast iron, then on the score of safety to human life alone, the metal belongs in every car wheel. A still better method would be to use a more powerful deoxidizer than manganese, and add the vanadium on top of it.

The results shown in the tables speak for themselves, and the averages tallied off for each table shows a remarkable progression of values. To increase the breaking strength of a test bar from 2,000 pounds up to 2,500 pounds for gray iron, and 1,500 pounds up to 3,900 pounds for white iron, is sufficient to warrant further investigation on the part of every foundryman who has special problems in strength to master, and this part of the investigations is therefore given to the foundry trade at this time, rather than to wait for the further tests still on the program. It is expected to continue the investigations on vanadium in cast iron further, making provision to keep the ladle with melted iron heated up for a fairly long period, so that a better mixing of the alloy may result, and hence more accurate results can be obtained.

In conclusion, the writer desires to acknowledge his debt to the Vanadium Alloys Co. for the generous donation of metals, fuel, alloy, and the making of the analyses (through Francis J. Peck & Co., of Cleveland) and a handsome donation toward a testing machine. The writer with the assistance of his men, did the rest.—*Transactions The American Foundrymen's Association.*

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The February meeting of the Pittsburg Foundrymen's Association held in the auditorium of the Engineers' Society of Western Pennsylvania Monday evening, Feb. 3, was devoted to a paper on "The Heat Treatment of Steel Castings" by W. M. Carr, of New York. A general discussion on the subject of annealing followed the paper. The membership of the association has now passed the 100 mark.

CYLINDRICAL SECTION SWEEPING DEVICE

Equipment for Sweep Molding Sections of Large Cylindrical Castings

BY JABEZ NALL

IT IS often necessary to divide large cylindrical castings into sectional parts, as two, four, six or eight, to meet shipping requirements, or for other reasons that suit the purpose of the designer. A common method of making such castings for smaller sections as quarters or less, is by the use of a skeleton pattern to form the outlines, the body being struck off by a sweep board and the metal thickness is formed in sand. For half circles it is customary to sweep up two halves in one mold by building up one-half, then sliding the spindle over the amount of thickness of the splitting cores, plus the amount of finish allowance, or by the use of an eccentric giving the correct throw-over, the latter method being the most accurate and desirable.

New Method.

This article is intended to show a better method, that has given satisfaction and has effected great economies. By its use, any reasonable number of part sections may be swept up without change of spindle, or in case of a loam mold without breaking the continuity of the brick-work, the molder proceeding the same as when making a full circle. All plates, or necessary rings can be made for the complete circle thus insuring the rigidity of the mold.

Any shape of casting that can be formed by a sweep board clamped to an ordinary spindle, can equally as well be made by this method, and the example we have chosen of a 14-foot diameter, dome casting, having a 60-inch outlet, made in quarter sections, is selected simply as an illustration of the device, and not with the idea of demonstrating the methods, principles, or possibilities of loam work.

Details of Sweep.

The device is shown in detail in Fig. 1 in which A represents a sliding arm to which may be bolted any desired sweep board. This arm has a projection as shown, carrying a guide roller which is secured by the pin and nut shown in the enlarged section at B, and is arranged to fit in slide C, which has a loose cap for attaching it to the spindle. These should be bored, and the slide planed to an easy working fit.

A plan view, section and front elevation of the head with the roller path is shown at D. This path, by careful molding, may be cast to shape, but the head should be finished as marked and the strips on the underside planed on the quarters corresponding with the centers of the roller path. These are used as guides for the straight edge in marking centers on the mold.

This head is clamped securely to the spindle with three set screws. The spindle differs from the ordinary, only in that some provision must be made to prevent its turning in the socket. The regular spindle and socket may be used by having a hole drilled through and a pin inserted in the spindle, the same lying in a groove made to receive it in the top of socket, as shown in Fig. 2. This groove must be deep enough to make sure of the fit of the spindle in the taper of the socket. Plan views of heads for circles divided into two, or six parts, respectively, are shown at E and F, Fig. 1.

The three heads, as shown, require a splitting core 2 inches thick, with a finish allowance on each face of the

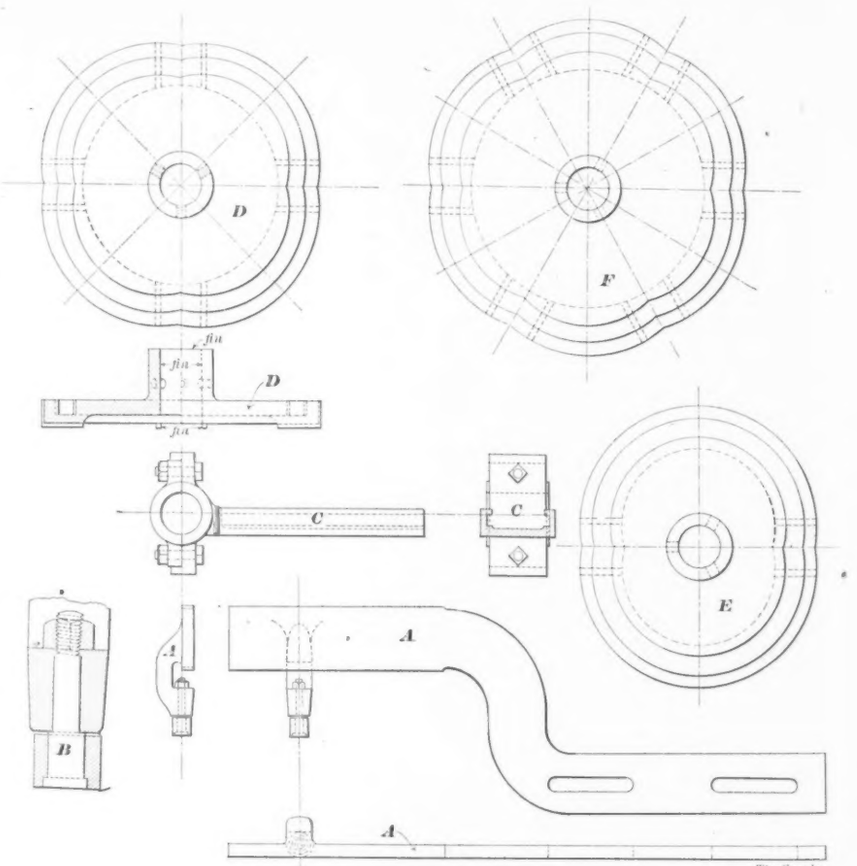


FIG. 1—DETAILS OF SWEEPING DEVICE AND HEADS FOR CIRCLES DIVIDED INTO TWO, FOUR OR SIX SECTIONS AS SHOWN AT D, E AND F

Editor's Note.—This article was awarded third prize in the contest conducted by THE FOUNDRY.

joint of 3/8 inch. From the plan view of head, it may be readily seen that this can be arranged to meet other requirements should they vary from this practice. These parts are shown assembled in Figs. 2 and 3 with the sweep board for the cope attached, together with a part of the structure of this half of the mold. This is swept up in an inverted position to the mold proper, and requires rolling over. This would be a drawback in some foundries because of insufficient head room or crane power for rolling over, but this is no fault of the device, as the foundry lacking equipment for rolling such a section is certainly lacking in up-to-date facilities. If the lack of head room makes it impossible to roll this in the chains while suspended on the crane, the mechanic of ability will always be able to devise some means by trunnions and stands, or some other way, provided he has the required crane power to lift the piece.

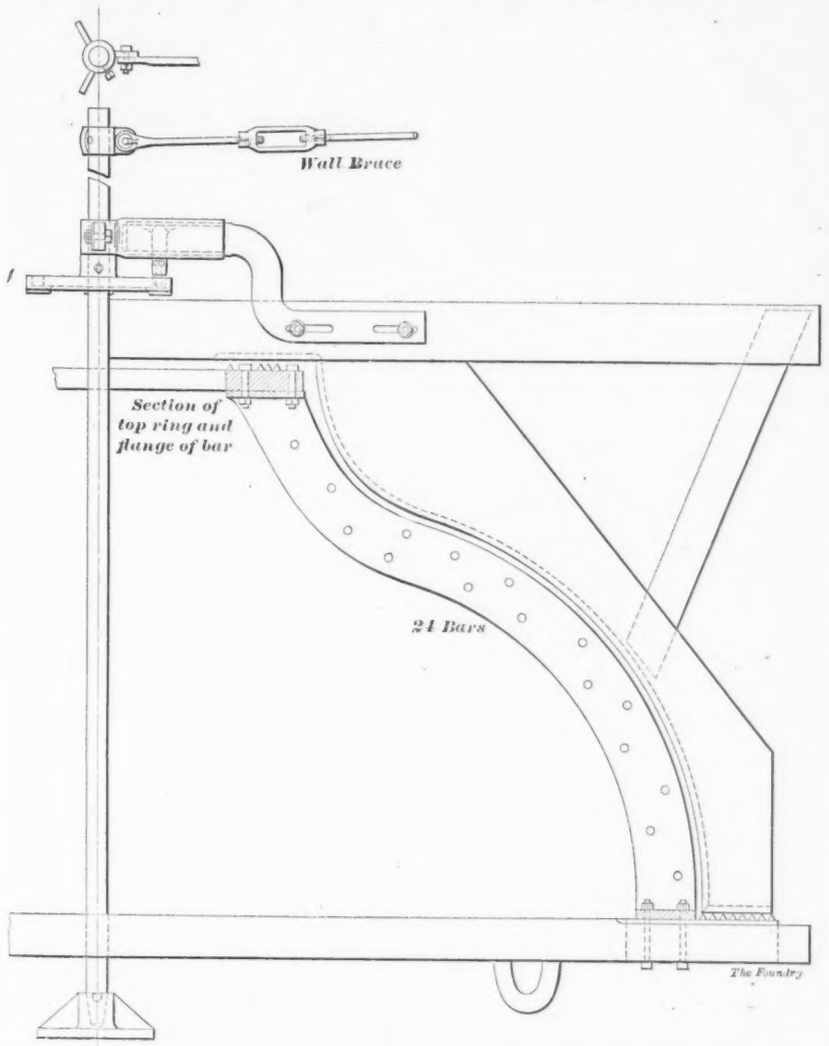


FIG. 2—FRONT ELEVATION OF SWEEP ARRANGEMENT AND PART SECTION OF THE FRAME OF THE COPE

Equipment for Cope.

The requirements for the cope half of the mold include a heavy lifting ring of sufficient thickness to insure rigidity, while handling. This ring is provided with lugs for rolling, as shown in Figs. 2 and 3, and four eyes for lifting. It is liberally supplied with "dabbers" for securing the loam to its face where required, and has cored holes properly spaced to receive the bolts for bolting the 24 connecting bars that secure this to the top ring. This ring is also liberally supplied with "dabbers." The bars have a sufficient number of holes through which are placed rods for securing the brick-work. Special care must be taken in building up as this must be a permanent mold as the number of castings required in this case was 24. The framework is securely bolted together and placed in a level position wherever it is desired to build it up.

The spindle, with head D secured temporarily, is then set in its socket with the pin lying in the groove as shown and is secured at the top with some form of a wall brace. Slide C, with sliding arm A in place, is then adjusted to the spindle, resting on the hub of head D, with roller B in mesh with the path provided for the same. With the arm lying on the center line of the splitting core, the sweep board can be set level abutting the spindle, and after the bottom has been tested by a size stick and the whole adjusted to the correct height and secured, the building, loaming and finishing of the mold is proceeded with in the usual manner.

The center lines must be carefully marked on the joint as these are depended on for setting the cope in place.

The Drag.

Fig. 4 shows a part section of the drag half of the mold in process of construction, taken on the center line of the splitting core. The print for the same with flanges attached are shown in place. It will be found convenient to have these in two parts, jointed as at L, Fig. 4. This allows for the setting of the sweep board for making the face of the mold, or the parting joint at K. The mold thus parted allows the small part of brick-work overhanging flange J to be lifted out with the casting without damage to the greater part of the mold.

A section of a ring set in the lower part of the brick-work having four holes to receive the core prints for the splitting cores is shown at H. This ring helps to bind the bricks at this point, keeps the mold in shape, and when once accurately set for the first casting, precludes the necessity of doing the work of setting these core prints over again for the subsequent castings. The structure of the drag is somewhat similar to that of the cope and needs little explanation.

As this mold, once made, is not again disturbed until the job is completed except to patch up any loam made defective by lifting the casting and to rebuild the small section overhanging flange J, a smaller number of bars will be found sufficient for the drag half, 16 being suggested.

Skeleton Pattern.

Fig. 5 shows a front elevation of a projected sketch of the skeleton pattern, lying in position for molding in either green sand, or for a skin dried mold. This will give the reader an idea of the size, shape and cost of the flask required, and the difficulty that would be experienced in correctly sweeping this out by hand. This illustration further shows the extra amount of work in taking out the sand forming the metal thickness, the venting, and refacing of the drag, and the liability of the mold to strain when casting.

Comparison of the Two Methods.

In contrasting the results of two methods of making these castings by skeleton pattern in green sand, or by making them in loam as shown, it will readily appear,

that for obvious reasons, it would be unfair to give the correct data of cost, but it would be a conservative estimate to say that between the green sand and loam methods, the cost of the first four sections or one complete dome would approximate the same figure. Afterwards a complete circle of four sections could be made in loam at a less cost than one section in green sand with results in quality, appearance, and truth of metal thickness, all in favor of the loam method.

The only way that the cost of the green sand mold could be reduced, would be by making a special flask for the drag and cope that could be rolled over, having a matched joint conforming to a parting that would give the minimum amount of lift in the cope, and by adding very largely to the cost of pattern work by demanding a full and complete pattern, in the form of the required casting. This, of course, would not be an impossibility, but would still be quite a job for the patternmaker and would make a large hole in the lumber pile.

Some other example may have shown up better in results in favor of this device than the one illustrated in this article, yet it adequately shows what economies can be attained by its use.

MAKING MALLEABLE CASTINGS WITHOUT ANNEALING.

By Dr. Richard Moldenke

A German foundryman has written for details of the American practice of making malleable castings without annealing, by the use of scrap iron, and chemicals. The American malleable founder will wonder whose circular the German manufacturer got this time, and were it not for the many thousands of dollars already lost, and still to be lost in the chase of this "will of the wisp," the question might well be passed and valuable space saved.

However, process after process has been brought to the attention of the malleable castings founder, all designed to shorten, but so far, not to obviate entirely the annealing process. All apparently do what is claimed of them, but all of them fail if applied commercially. I have seen plant after plant fail where such methods have been tried, or else they return to the old reliable long time anneal at low temperatures.

Reasons for Failures.

The reason is clear. Making malleable castings is a question of the proper heat treatment of a cast iron of a composition peculiarly adapted for this purpose. All malleable men know that it is possible to anneal, that is change the combined carbon to the so-called "temper-carbon" in a white casting of suitable composition in a very short time by excessively high temperatures in the oven. But all these men also know that very frequently this will not work. Were the reason for this known, doubtless some simple process would eventually prove a commercial success, but unfortunately this is tied up with the physical structure of the iron as much as the chemical. In other words the inventors of these short anneal processes always claim when they fail, that they got improperly made hard castings to malleablize.

When reading the deep and illuminating papers of scientists who hardly know the inside of a malleable shop, and tell us how to get the perfect change of the carbons aimed at, at such and such a very high temperature, when the practical maker knows that with the long anneal he gets a better result at a temperature far below that claimed absolutely necessary to effect the change, one is tempted to reject such investigations as worthless. True, they are not worth the paper they are written on for the daily routine of the foundry, but might be made useful, if the investigations were carried to completion. Thus, this very question of unreliability of the hard castings for the quick anneal processes may be found, not in the chemical composition, though the unknown element of dissolved oxide may affect this seriously, but in the physical constitution of the casting. Take a hard casting, containing 0.65 per cent silicon, 0.15 per cent manganese, 0.04 per cent sulphur, 0.175 per cent phosphorus, and say 3.20 per cent combined carbon, with no graphite, and it will make a great difference in the annealed casting, the an-

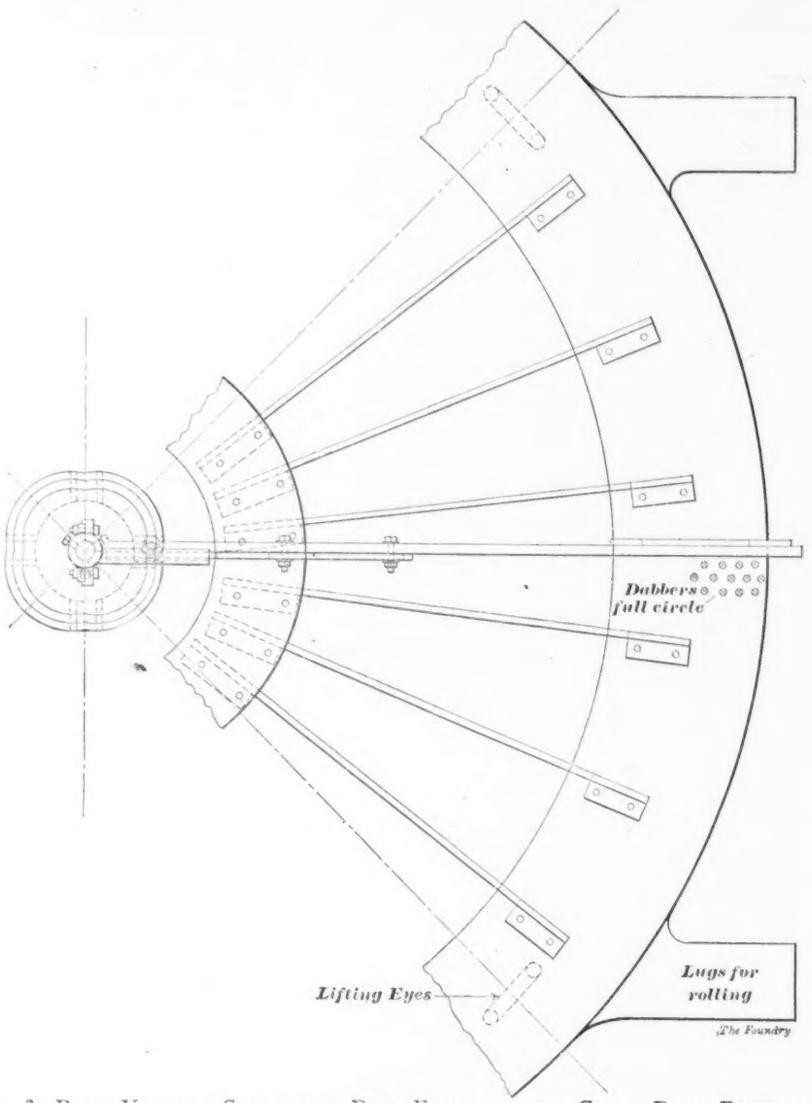


Fig. 3—Plan View of Sweep and Part Frame of the Cope. Rods, Bolts and Brickwork Are Omitted

nealing being conducted in exactly the same manner whether the casting was made of all pig, or half pig and half hard scrap of home origin, or of three-quarters pig and one-quarter sprues, or vice versa; or with the addition of steel scrap, or the addition of malleable scrap; or whether the cupola had been used in melting or the air or open-hearth furnace. Remember—this with the same final composition in the hard casting. Anneal the metal, which means first of all that the cupola metal would not anneal at all in the oven brought up to the lowest temperature of air furnace iron, and you have different physical strengths for different proportions of pig and scrap, etc. A high pouring temperature for the hard casting also means a difference in strength from that when poured colder, for the contraction of the casting is different, and they act differently while expanding in the anneal.

Quick Annealing Methods.

Now, in view of the above, what chance is there for a quick process which from the very nature of the case, cannot equalize the internal strains produced at the moment of set, in fact, would seem to introduce new ones in the rapid pushing apart of the structure of the iron to provide room for the temper-carbon that separates out and reposes between the iron crystals.

Until we know more of what actually happens in the hard iron before anneal, let alone the true inwardness of the annealing process itself, which shows the contradiction of results at low temperatures which the scientists tell you are not possible, it would be well to keep your dollars where they will do the most good in the regular way, and let quick annealing methods, with or without chemicals, severely alone. Nevertheless, we should not discourage experiments, but should do all we can to solve the mysteries of the metallurgy of iron that still confront us.

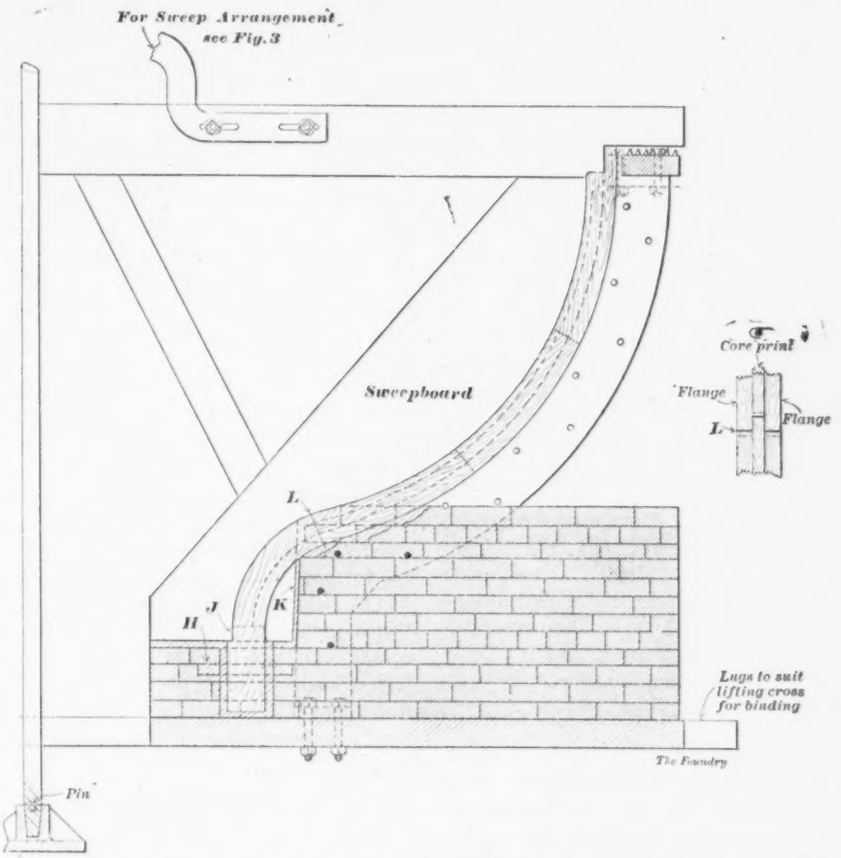


FIG. 4—PART SECTION OF THE DRAG HALF OF THE MOLD IN COURSE OF CONSTRUCTION.

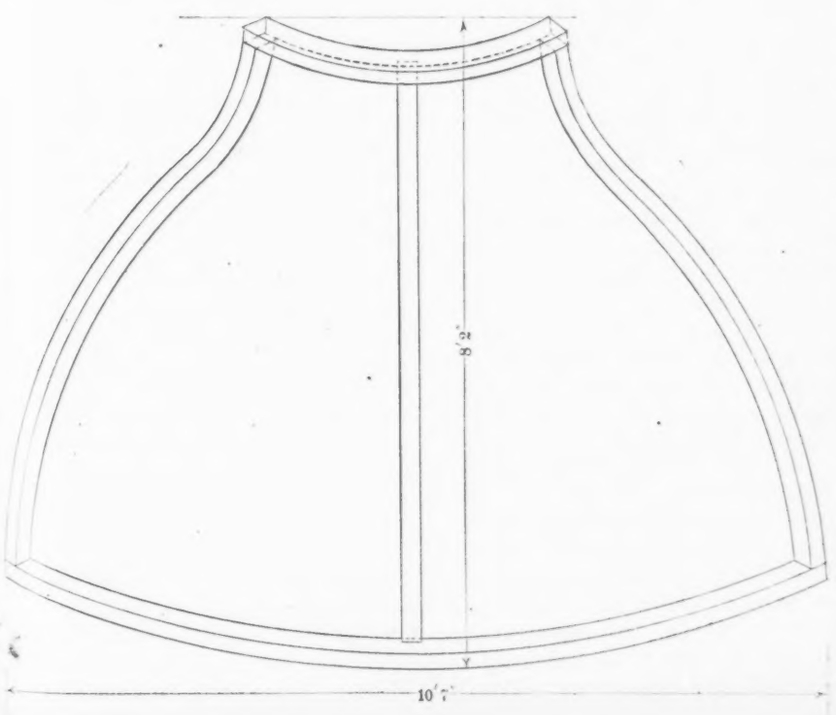


FIG. 5—FRONT ELEVATION OF SKELETON PATTERN

ACID-PROOF METAL.

An alloy useful for paper mill machinery casting where the bisulphite process is employed for manufacturing pulp is composed of copper, 82; zinc, 8; lead, 8. As a matter of fact it is only proof against weak or diluted strong acids, except nitric, which quickly attacks it.

BLOW HOLES AROUND AN IRON CHILL ROD.

BY W. J. KEEP

Question:—What causes blow holes around an iron chill rod?

Answer:—Rust on the surface. Coat the rod with a wash of plumbago and kerosene. Do not put this into the mold until just before pouring, and it is preferable to warm the rod before using.

PRODUCTION OF MALLEABLE CASTINGS—II

Characteristics of Malleables and Their Physical and Chemical Properties—Methods of Testing

BY RICHARD MOLDENKE

TO OBTAIN an idea of the value of a material, it is well to compare its properties with those of similar substances; thus gray iron castings range from those nearly black in fracture to white, with all degrees of softness to glass hardness. They may be strong or weak, but still serve their purpose. The desirable characteristic, however, of the gray iron casting is its extreme resistance to compression. Where shock is to be cared for, great massiveness is required, but again the metal may be run into any desired form with comparative ease.

The steel casting has the highest strength so far attainable in cast materials coupled with no undue difficulties in the making. It may be deformed considerably without danger, and is cheaper than a corresponding forging.

Characteristics of Malleable Castings.

The malleable casting is somewhere between the two above mentioned. It is stronger than the gray casting, but not as strong as cast steel. It can be bent and twisted considerably before giving way and approaches cast iron in compressive strength; but its most valuable characteristic is resistance to shock. For the repeated stresses of severe service the malleable casting ranks ahead of steel, and only where a high tensile strength is essential, must it be replaced by that material. This is best illustrated in the passing of the car coupler made of malleable cast iron. Not only have a large number of drop tests shown the high value of the malleable coupler as compared with one of cast steel, but the scrap heap tells an interesting story. In making comparisons of broken malleable couplers with steel, a large number of each were selected in which the heads were badly battered by the succession of blows occurring in railroad service. Coupons were cut from the barrels of these couplers. These, when pulled apart in the testing machine, with but few exceptions, gave the palm to the malleable casting.

Malleable and Steel Compared.

A study of the characteristics of malleable and steel will explain this to some extent. The constitution of the steel casting as shown by the microscope is found to be in the nature of distinct crystals of pure iron closely packed together with other crystals of iron carbide. There is no space between these groups and aggregations of crystals to amount to anything. Hence, batter them and they will separate along the lines of crystallization, and cracks will extend somewhat like in the gray casting. Where actual cracks or separations of crystals do not occur, there is at least introduced a series of strains, not unlike the casting strains the founder is so familiar with, so that no matter how good the material was originally, but little further pressure put on it, will bring about failure. When, therefore, a steel which should ordinarily resist a strain of 65,000 pounds per square inch, and doubtless did when the coupler was new, fails under but 20,000 pounds, it would show that this material was not the best for shock resistance.

Carbon.

On the other hand, the malleable casting, consisting also of crystals of iron, though very impure, has within its structure a net work of free amorphous carbon particles called temper-carbon by the late Prof. Ledebur, the famous German authority on malleable cast iron. In other words the malleable casting is for practical purposes a poor steel casting with a lot of graphite, not crystallized, between the crystals or groups of crystals of the steel. This naturally makes the material weaker on a direct pull, but when it comes to shock, the blows will batter the face, but the compression of the cushions of carbon will effectually prevent the transmission of the force very far. The fact that the carbon or graphite is not crystallized in the malleable casting, as it is in the case of gray iron, explains why the former is so much stronger. The graphite found in cast iron represents planes of weakness, a distinct separation of the metallic particles, so that when pulled, only a very small portion of the iron holds together. In the case of malleable there are no such planes of weakness, and hence the small spaces taken up by the carbon present in its free, uncrystallized form do not interfere so much with the holding together of the particles of iron.

It may be said in passing, that as between the steel casting and the malleable, if the first is not properly annealed before being shipped there are always remaining serious casting strains which are bound to weaken the product. Hence the shipment of unannealed steel castings, except for use where great strength is not a factor, should not be countenanced. On the other hand, the malleable casting, when well made, is a finished product. The heat treatment received is ideal. Brought to red heat quickly, held there a fair length of time, and then allowed to cool gradually, all strains are removed. The material is in perfect equilibrium and can therefore carry its proper load safely. It must, however, be well made to do this, for when malleable is bad, it is utterly so.

Malleable cast iron being cheaper than steel makes it a prime favorite with the railroad man, for agricultural work, pipe fittings, and in all construction work involving a great number of pieces from the same pattern. Competition keeps the price of the malleable casting between the gray iron and the steel in the United States; in Europe it often is the highest priced of them all.

Strength of Malleable Castings.

A study of the strength of malleable cast iron, carried on for many years, has shown the writer not only the remarkable improvement brought about by the better regulation of the methods of manufacture, but also what might be done were it possible to produce an absolutely uniform product, one casting identical in its structure with the other. Time and again concerns have started in business attempting to exploit some supposedly new method of shortening the annealing time, or in addition to this, recarburizing the skin of the casting to make steel (?), only to fail in the end. An almost unbroken series of runs would turn out successfully, or would be fairly so, and then would come a batch of castings with which nothing could be done, though these castings when treated in the ordinary way would anneal all right. Simply the lack of uniformity,

due not only to the varying composition, but also the changes made in the proportion of scrap and pig iron were to blame. The latter cause will eventually be traced more clearly to oxidation of the metal to a greater or less degree by poor melting practice, or too great a number of remelts. This lack of uniformity is more apparent in the heavier classes of castings than in the light. It is quite possible to make a line of thin cutting tools, such as wood chisels, hatchets, etc.; case harden them, and finish up for the market. Many a patternmaker and carpenter uses a chisel he fondly imagines to be made of the very best cast or tool steel, which in reality is only a case-hardened malleable casting. It is only when breaking the tool in its thicker parts that the "black-heart" characteristic of malleable cast iron appears. The reason for this condition will be explained later. In the case of heavy work, where it is necessary to work down to pretty close limits in the silicon of the mixture in order to get good results (so close, in fact, that the limit is sometimes overstepped, and burnt iron results), it is practically impossible to get material uniform enough with which to try metallurgical tricks. The result, therefore, must always be disastrous to an enterprise based on so insecure a foundation.

Peculiar Annealing Methods.

It is quite amusing to receive work made by such processes preliminary to a desired investment, and upon opening the package to almost invariably find a hatchet with the edge turned over slightly. Not only the shortening of the time of anneal, but the introduction of chemicals, gases, and what not, into the pots forms the basis of these inventions. The bright geniuses in question forget or do not know that it is perfectly possible, though not good practice, to anneal a hard casting of the proper kind in a few hours at a very high heat, as well as to get first rate results in the ordinary annealing process by packing the castings in brick-dust, fire-clay, or sand. Foundrymen should therefore fight shy of these inventors, at least until they can prove some new principle, and the possibility of handling the whole gamut of malleable work with uniformly good results. This part of the subject of characteristics of malleable cast iron may therefore be dismissed until the art of annealing is taken up.

Constitution of the Material.

Before taking up the question of testing malleable cast iron, a few more words should be said on the constitution of the material. Take a thick, flat piece of malleable and plane off the skin, say 1-16 inch deep, and gather the chips for analysis. The carbon will be found to total up to say 0.15 per cent, perhaps even less sometimes. Cut in another 1-16 inch and the total carbon will be nearer 0.60 per cent. Now go down successively by sixteenths and the total carbon will range from say, 1.70 per cent, 2.90 per cent to 3.65 per cent and will then remain constant until the center is reached. Then going further the process is reversed. For practical purposes, since the temper carbon, of which this total carbon consists almost entirely, will become combined carbon on heating high and quenching the piece, the skin of the casting may be considered something like wrought iron. It cannot be hardened by quenching, but can be satisfactorily case-hardened. The next portion of the casting is in reality a tool steel and can be hardened, and finally the interior is a cast iron, however, an iron but little short of the strength of the whole piece.

Interior of Malleable Castings.

This second portion is interesting, as it is the part of the casting in which the crystals have arranged themselves at right angles to the surface. In the annealing process, in expanding under heat, this may allow a penetration of oxygen from the scale to remove carbon, as is generally supposed, but more likely a migration of the carbon outward without penetration of oxygen takes place, as the writer holds. The result is a pretty sharp change from a lower carbon content to the full amount of the center where the crystallization is mixed in every direction. An inspection of the fresh fracture will show the founder accustomed to this, between the white, steely rim, a more or less wide band of material lighter in shade than the black interior. This is the zone of crystallization at right angles to the surface, and this is the portion of the casting which is used for the cutting edges of chisels, milling cutters, etc., which are sold as cast steel.

Carbon Analysis Worthless.

There is a further deduction to be made from the above and that is the worthlessness of any carbon analysis for malleable. Unless the sample is taken right out of the middle, or planed off as given above, and the facts stated, the determinations made for carbon are of no use. Even boring right through the casting, gathering all the drillings, and using them all for the determination is only an approximation of the truth. To get some light on this point, it is necessary to take the total carbon of the casting before it is annealed, and then one may know what to expect from a heat which runs, say 2.85 per cent total carbon, as compared with one running 4.06 per cent.

There is but a slight variation in the quantity of the rest of the elements present before and after anneal, the carbon alone being affected. This is changed from combined carbon to temper-carbon throughout the mass, and partly removed in what is called the skin and a little further inward. Other characteristics of malleable cast iron will be described in connection with the processes involved.

Testing Malleable Iron.

Malleable cast iron is tested in two general ways—by shop tests, and laboratory tests of bars cast from every heat and annealed with the castings. Apart from the so-called "test," taken from the heat while this is going, and which will be described under the caption of melting, the usual shop tests consist of bending occasional castings, twisting the longer pieces, making and breaking so-called "test-wedges" separate from castings; and casting "test plugs" on the more important work. The latter, when broken off just before their final preparation for the market, show up the quality of the particular casting. These are in effect the "test coupons" of steel practice, but much smaller.

In testing castings taken at random from the pile of discards, as they come from the soft-rolling room, what is looked for particularly is that the heart is sound, black, and the white rim not too pronounced. The casting should bend well before yielding, batter out to show softness, and the skin should be clean, free from pin holes, with the edges sharp. The interior should not show sponginess or "shrinkage," as it is called—but true shrinkage and not the contraction in melted metals from set to coldness erroneously called shrinkage. This shrinkage is a serious point with the malleable man, as it is the cause of most of the failures on the part of castings. To overcome this difficulty it is usually necessary to use chills in the molds at the danger points, as will be explained subsequently.

Test Wedges.

The test wedges used in the shop are about 6 inches long, 1 inch square for 3 inches of the total length, and then tapering down in thickness for the last 3 inches to nothing, but keeping the full inch width. This gives thick iron as well as thin on the same piece. These wedges are cast at the same time as the regular test bars for the laboratory, and are labeled to correspond.

When the test wedges come from the anneal, being placed there with the test bars, in the center of the pot which stands in the middle of the oven, the annealer breaks them on his anvil, striking a succession of short, light blows. The object is to see how much the thin

end of the wedge can be bent before the piece breaks. After breaking, by simply holding the two parts together, and observing the bend, a very fair idea of the quality of the castings these wedges represent may be had. The break, by the way, is made to take place in the middle or rather toward the inch square side of the wedge.

Method of Labeling Wedges and Test Bars.

In labeling the wedges as well as the test bars, the following method will be found well adapted for the purpose. Number the furnaces for example from one to ten or one to four as the case may be. Then number the heats in each. Thus heat Nos. 1, 2, and 3, if there are that many in one day. Next, designate the first part and the last part of the heat by one and two. Finally put on the date. Taking either the wedge or the 14-inch test bar, put the furnace items on the left hand end of the bar, and the date on the right hand. These numbers are obtained by pressing the ordinary steel figures as used by the machinist into the mold before closing.

Now take for instance the last part of the third heat of furnace No. 8, cast on November 15. This would appear on the test bar or wedge as follows:

8 3 2	11 15

Or the first part of the first heat of furnace No. 2, on March 8. This would appear:

2 1 1	3 8

This locates the bar and consequently the castings corresponding to it at once and tab can be had on the quality as shown by the tests.

Important Advantages.

There is a further very important advantage to be derived by making these test wedges. In the larger works it is almost impossible to keep track of the condition of the furnaces, more especially if the open-hearth type is used, unless the laboratory has the evidence at hand for the benefit of the melter, superintendent, as well as the manager of the concern. The tendency on the part of the shop management is naturally to get out the very last heat possible before repairing the furnace. This always means that the product suffers. Similarly, annealing ovens are run as long as they will keep from collapsing, with resulting underannealed work to the detriment of customer and works' reputation alike. Unless the very head of the concern can, by casually stepping in at the laboratory, see exactly how things are running, and give the necessary orders to correct the trouble, much bad iron will go out. By building a little cupboard with about 20 shelves with 2½ inches or so clear space between each for the storage of the broken test wedges, these useful castings, after being broken and inspected, may be placed on the shelves in regular order of furnace number and heat, with the date chalked on the shelf. After having two or more weeks run on exhibition, by glancing down the shelves, the product made by each furnace can be readily traced, and its condition seen by the white rim of the castings. Suppose the work of the establishment is heavy, and the open-hearth furnace is used, as this gives the best results, the silicon will be pretty low to start with, and with regular time on the part of the heats, the fracture of the wedges should show up normal. Suppose the ports of a furnace are burning away, the checker work is choked, or other troubles begin to appear, the first effect is to prolong the heat. It will not be gotten ready in the regulation time. The consequence is that the silicon burns out to a greater extent, and we get into what is technically termed "high" iron. That is, the silicon gets too low. The castings will not anneal well, and the first indication is a widening rim of white in the wedges and test bars. The trouble will increase, the iron not only being too low in silicon, but burning. This will result in pin holes in the wedges, later big blow holes and white rims a quarter inch wide. Finally the trouble gets so bad that the castings will not anneal at all, and the wedges are full of blow holes, and entirely white, though not crystallized as the original hard iron. Long before this, the furnace should have been put out of commission and repaired. The record of the wedges shows the trouble one week after casting, not before, and if the white rim is allowed to become quite broad, it is very probable that at the very time, the castings being made and going into the annealing are worthless. The annealing requires a week, and hence six days' castings are always a doubtful quantity when trouble is the order of the day. This accounts for the heavy losses when things are not going right. Formerly, castings thus made, were duly shipped out, but at the present day buyers are becoming wiser and owners more jealously guard their good name.

Twisted Castings.

In order to induce prospective customers to purchase, they are oftentimes shown wrenches twisted several times, or ¼ inch flat pieces bent into circles 6 inches in diameter. These are very nice to look at, but in reality not very serious problems in foundry work. Taking a twisted wrench, it will be noted that for every inch in length, but a very small curvature is given the metal. Similarly, in turning a circle with a flat piece, this is done by striking every part of it slightly, giving every half inch of it a little bend. A much more difficult feat is to take a heavy casting under the steam hammer and flatten it out without breaking, as for instance boiler nuts, and this can be done with good malleable castings.

It is therefore better for the manufacturer not to show too many of these freaks, as the customer is apt to try them himself with what he gets from that foundry. It is much better to invite the prospective customer into the laboratory and show him the testing being carried on. He will then realize that every precaution is being taken to turn out good work, and go away satisfied that he can do no better elsewhere.

Use of the Test Plug.

There remains still the test plug to be considered. It has long been the custom of the founder to add small chunks of metal to his important castings. These are broken off after annealing, and by the manner of their breaking, as well as the fracture exposed, indicate whether the casting can be safely shipped. The size of these plugs is always aimed to be large enough for easy handling, but not too large, so that in breaking off, the metal may not be torn out of the body of the casting. Thus, for work as large and heavy as car couplers, the test plugs, placed in several vital parts of the casting, would be an inch wide, five-eighths thick, and an inch long. In the case of other castings, the plug might be half an inch square and three-quarters of an inch long. Still other sizes would obtain the thickness approximating the section of the casting. In breaking these plugs off, they are to be struck on the outer edge with light blows, giving the iron a chance to bend and break off not too suddenly. A sharp, heavy blow will knock the plug off, but leave a fracture that may be perfectly white. This is due to the tearing apart of the crystals of iron, thus masking the free carbon present. The same plug broken off a good casting as above described would leave the fracture a fine velvety black. These test plugs, by the way, should be preserved for use in the soft rolling room, as they give up their graphite and polish the annealed castings nicely.

Manufacturers have always strenuously objected to leaving some of these test plugs on the castings they ship out, in

most cases grinding away the fracture surface, so that it may not be known that test plugs were used. Customers, however, who are sufficiently important to enforce their demands, have in this method a means of satisfying themselves, that at least as to process of manufacture, their purchases are correct, whatever may be the quality of the metal as revealed by the regulation tests.

ERRATA.

As Dr. Richard Moldenke was unable to revise the proofs of his first article on "The Production of Malleable Castings," which appeared in the February issue, it contained a number of errors and the corrections and amplifications are as follows:

Page 257, first column, five lines from the end.—After "methods," add *provided everything is running smoothly—and the malleable casting has very valuable properties to commend it.*

Page 258, first column, 20 lines from the end.—"Somewhat doubtful" should read *very probable.*

Page 258, second column, 22 lines from the end.—Eliminate *assumes that he.*

Page 258, third column, between the tenth and eleventh line from the end, insert, *the ability on the part of the melter to start anew, in case of trouble, by taking a heat of straight No. 2 irons.*

Page 258, third column, seven lines from the end.—Eliminate *in those days.*

Page 259, first column, sixth line should read *the production of new malleable and basic steel.*

Page 259, first column, 16 lines from the end, change, "all coke grades" to *some works came to mistrust all coke grades.*

Page 259, first column, eight lines from the end, after "pursued," add *such as using as much as possible in a heat, then repeat, using the sprues of the first heat, casting test bars for trial.*

Page 259, first column, two lines from the end, for "limited" insert *with but little cinder.*

Page 259, second column, second line, change "less" to *more.*

Page 259, second column, 24th line should read *the introduction of steel scrap.*

CAR WHEEL CHILL.

A patent has recently been granted B. M. Carr, superintendent of the machinery department of the Dickson Car Wheel Co., Houston, Tex., on a car wheel chill that is inexpensive to construct and of a novel design. The chill consists of a series of segments made right and left as shown at E and F, Fig. 1, provided with dovetail ends placed together to form a circle, with a small spacing strip on the face for the purpose of forming the slots and for releasing the gases from the mold. The strip A on the face of the segment is removed when the inside diameter of the chill is machined, which leaves the two strips B and C. One of these segments is made with the spacing strips and the other one plain and by placing the two together they form a passage for releasing the gases from the mold.

The two side strips, B and C, remain to hold the segments in position. A ring of metal D, as shown in Fig. 1, is then cast around the dovetail ends of the segments, which binds them together. As the faces of the segments are not machined, they retain the outside surface or skin of the iron which protects them from the action of the hot metal. The slot thus formed is from 1/64 to 1/32 of an inch wide, and is much smaller than can possibly be made when the slots are cut by a saw, as 3/32 of an inch is required for the saw blade.

After the ring has been cast and the segments are firmly held in place the only work necessary is to bore out the chill to the diameter of the wheel. This permits the use of the chill the day after it has been cast and obviates the necessity of cutting the slots. The segments are made on molding machines and require no cores nor is any drilling necessary, as the two segments laid together each form half of the hole for the drag pins or receiving sockets shown at G, Fig. 2. While only two drag pins are ordinarily employed in operating the chill, the large number of drag pin receiving sockets is important for two reasons. First, the drag pins can be moved to different points to receive the drag ring, and second, the sockets constitute additional vents to permit the escape of gas from the mold.

For many years it has been recognized by the leading railroad interests that wheels made in contracting chills are superior to those made in plain chills. The sawing of the slots, 98 in number, in a chill for a 33-inch wheel is an expensive operation and requires considerable time to accomplish. The life of some of these contracting chills with slots cut in this way, especially if the iron is soft so that it can be machined readily, is said to be very short. If the castings are hard it adds to the life of the chill, but longer time is required to machine the same. Furthermore, the grain of the metal is exposed when the slots are cut in this way and in a very short time the hot iron attacks the chill and burns out the slots, resulting in bad spots on the tread of the wheel which cannot be ground out. Frequently the strain in the chill casting is relieved by the cutting of these slots and after the hot metal has been poured against the chill it frequently warps, resulting in imperfect wheels.

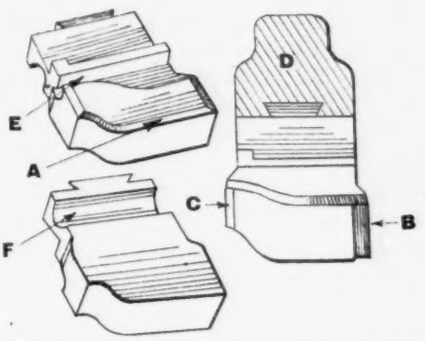


FIG. 1—SEGMENTS OF CAR WHEEL CHILL

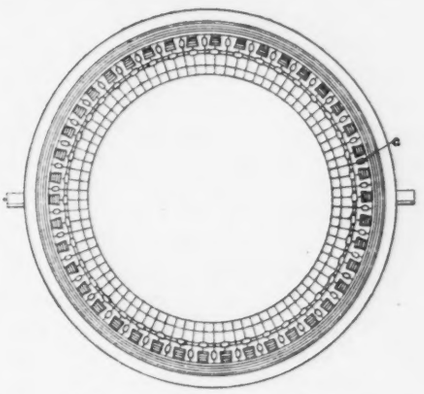


FIG. 2—CAR WHEEL CHILL

A. F. A. CONVENTION AT TORONTO

THE EXECUTIVE committee of the American Foundrymen's Association has accepted the invitation of the Toronto foundrymen to hold the 1908 convention in Toronto. The allied organizations, including the Brass Founders' Association and the Foundry Supply Association, will meet at the same time.

The Foundry Supply Association will hold an exhibit of foundry supplies and equipment, for which extensive preparations are now being made. It was at first intended to hold the meeting the first week in June, but to avoid the crowded condition of the hotels in Toronto that week, as the circuit races have been set for that time, it has been decided to hold the convention the second week in June.

A meeting was recently held at the headquarters of the Canadian Manufacturers' Association, Toronto, to make preliminary arrangements for the annual gathering. The meeting was called by L. L. Anthes, vice president of the American Foundrymen's Association, and the different organizations and bodies interested in the convention were represented.

Those present included L. L. Anthes, Toronto Foundry Co.; Dr. Richard Moldenke, secretary of the American Foundrymen's Association; H. M. Lane, secretary of the Foundry Supply Association; C. H. Wheaton, Dodge Mfg. Co., Toronto; S. H. Chapman, Ontario Wind Engine & Pump Co., Toronto; E. G. E. Holker, Wilkinson Plough Co., Toronto; David Reid, Canadian Westinghouse Co., Hamilton, Ont.; W. R. Beers, Detroit

Foundry Supply Co., Detroit; F. W. Moffat and J. K. Moffat, Moffat Stove Co., Weston; J. P. Murray, Ed. Flaysing and J. S. McKinnon representing the Canadian Manufacturers' Association.

Dr. Moldenke directed attention to the work of the American Foundrymen's Association, and pointed out that its objects were purely educational. He reviewed the history of the organization, and called attention to the influence it has had in the development of the foundry industry in America as well as in other countries. He gave some hints in regard to the arrangement of the program, and suggested that this year more attention be paid to the educational features of the convention than heretofore.

H. M. Lane then spoke in the interests of the Foundry Supply Association, and pointed out that these two associations had worked together during the past two years, and enlarged upon the value of the exhibits made by the Supply Association at the conventions.

Mr. Murray and Mr. Freysing spoke in the interests of the Canadian Manufacturers' Association. Both stated that their organization will give the annual gathering their enthusiastic support.

L. L. Anthes read letters from various Canadian manufacturers and from others directly interested, which reflected the interest that Canadian foundrymen are taking in the convention. These concerns all heartily endorsed the invitation which has been extended to the American Foundrymen's Association and promised their co-operation.

The facilities for the holding of the sessions and for making the exhibits were discussed, and those present were favorably impressed with the arrangements that could be made at the Toronto Exhibition grounds. Mr. Lane gave some idea of the magnitude of the exhibits which would be made by pointing out that $12,000 was spent by the association last year in the mere placing and arranging of the exhibits.

Dr. Moldenke estimates that fully 2,000 will attend the convention. As at Philadelphia, the entertainment features will be confined to the members of the allied associations, including the American Foundrymen's Association, the Foundry Supply Association, the Brass Founders' Association, and the Associated Foundry Foremen.

Those wishing to exhibit should communicate with H. M. Lane, secretary of the Foundry Supply Association, 1924 Prospect avenue, Cleveland. Those who wish to join the American Foundrymen's Association and attend the convention as visitors should communicate with the secretary of that organization, Dr. Richard Moldenke, Watchung, N. J.

The secretary of the Brass Founders' Association is Andrew M. Fairlie, Tennessee Copper Co., Copper Hill, Tenn., and the secretary of the Associated Foundry Foremen is E. C. Everitt, care of the J. L. Mott Iron Works, Trenton, N. J.

Toronto is an ideal convention city, the exhibit buildings and the surrounding park are owned by the municipality, and two of the buildings are tendered for the use of the Supply Association, while the auditorium is to be used for the proceedings of the society.

Railroad switches enter the exhibit grounds at the side of Machinery hall, reducing the cost of labor and hauling to a minimum. In many cases permanent booths which have been constructed in the buildings can be secured so that the cost of exhibiting in Toronto will be only a small fraction of that which has had to be incurred at previous meetings.

Machinery hall is equipped with shafting, and both direct and alternating current for power and lighting purposes. Provision will also be made for compressed air and water. The floor in Machinery hall is tight and strong, and is suitable for supporting heavy machinery, and for exhibits in connection with which sand is necessary. The larger of the two buildings is known as the Process building, and is situated about 200 feet from Machinery hall. The floor in this building is as strong as that in Machinery hall, but the planks are laid with wide cracks between them, so that exhibits requiring molding sand could not be located in this building to advantage. Power is available in one section of the building from shafting operated by motors. The building also contains a number of permanent booths and spaces surrounded by railings.

CHICAGO EXHIBIT OF FOUNDRY EQUIPMENT AND SUPPLIES

THE Associated Foundry Foremen of Chicago and vicinity will hold their annual meeting and second exhibit of foundry supplies and equipment, at the Lewis Institute, Madison and Robey streets, Chicago, on Thursday, Friday and Saturday, March 5, 6 and 7. Thirty manufacturers of molding machines, oil and gas furnaces, core room equipment, pattern-makers' machinery and other foundry appliances have already made arrangements for space, and the indications are that the exhibition will surpass any undertaking of its kind heretofore held in the West. All of the exhibits will be arranged on the various floors of the Institute building, and practical demonstrations will be made, as ample power will be furnished.

The program outlined below will be carried out in so far as it is possible to do so, although changes and additions will undoubtedly be made:

THURSDAY, MARCH 5.

9 A. M.—Exhibition will open and continue until 10 P. M.
8 P. M.—Meeting in room 2, first floor of Engineering building. Address of welcome by President E. W. Smith of the Associated Foundry Foremen of Chicago and Vicinity.
"The Work of the Commercial Chemist," C. Kawin.
Cinematograph demonstration of the French system of universal machine molding by E. H. Mumford.

FRIDAY, MARCH 6.

9 A. M.—Exhibition opens.
2 P. M.—Ladies in attendance will meet in room 2, and will visit the domestic economy and other departments of the institute, visiting the exhibits later.
8 P. M.—Exhibition will close for the evening.
8:15 P. M.—Meeting in the auditorium of the Institute.
Address of welcome by George N. Carman, director of Lewis Institute.
Illustrated talk by E. A. Johnson, director of foundry work, Winona Technical School, Indianapolis, Ind.
Address by Dr. Richard Moldenke, secretary of the American Foundrymen's Association.
Music will be furnished during the evening by the Boys' Glee Club of the Institute.

SATURDAY, MARCH 7.

9 A. M.—Exhibition opens.
10 A. M.—Meeting in foundry class room of all instructors in foundry and pattern work in schools and universities, that are in attendance at the exhibition.
2:30 P. M.—The official photograph of the members and guests will be taken in front of the Engineering building.
8 P. M.—Smoker at the Sherman House, which all visiting foundrymen are invited to attend. Tickets for the smoker can be obtained from the executive committee.

Exhibits will be made by the following concerns:

MOLDING MACHINES.

Arcade Manufacturing Co., Freeport, Ill.
E. A. Delano Pulley Machine Co., Chicago.
Killing Molding Machine Co., Davenport, Ia.
Mitchell-Parks Mfg. Co., St. Louis.
E. H. Mumford Co., Philadelphia.
Henry E. Pridmore Co., Chicago.
Sandwich Mfg. Co., Sandwich, Ill.
Tabor Mfg. Co., Philadelphia.

CORE ROOM EQUIPMENT.

Brown Specialty Machinery Co., Chicago.
Diamond Clamp & Flask Co., Richmond, Ind.

STANDARD SPECIFICATIONS FOR CAST IRON CAR WHEELS.*

Chemical Properties.

The wheels furnished under this specification must be made from the best materials and in accordance with the best foundry methods. The following pattern analysis is given for information, as representing the chemical properties of a good cast iron wheel. Successful wheels, varying in some of the constituents quite considerably from the figures given, may be made:

	PER CENT.
Total carbon	3.50
Graphitic carbon	2.90
Combined carbon	0.60
Silicon	0.70
Manganese	0.40
Phosphorus	0.50
Sulphur	0.08

1. Wheels will be inspected and tested at the place of manufacture.

2. All wheels must conform in general design and in measurements to drawings, which will be furnished, and any departure from the standard drawing must be by special permission in writing, and manufacturers wishing to deviate from the standard dimensions must submit duplicate drawings showing the proposed changes, which must be approved.

Drop Tests.

3. The following table gives data as to weight and tests of various kinds of wheels for different kinds of cars and service:

Wheel	33-inch diameter Frgt. and Pass. cars.				36-inch diameter.
Kind of service	60,000 lbs. capacity and less.	70,000 lbs. capacity.	100,000 lbs. capacity.	Passenger Cars.	Locomotive Tenders.
Number	1	2	3	4	5
Weight { Desired	600	650	700	700 lbs.	750 lbs.
Weight { Variation	Two per cent either way.				
Height of drop, feet	9	12	12	12	12
Number of blows	10	10	12	12	14

Marking.

4. Each wheel must have plainly cast on the outside plate the name of the maker and place of manufacture. Each wheel must also have cast on the inside double plate the date of casting and a serial foundry number. The manufacturer must also provide for the guarantee mark, if so required by the contract. No wheel bearing a duplicate number, or a number which has once been passed upon, will be considered. Numbers of wheels once rejected will remain unfilled. No wheel bearing an indistinct number or date, or any evidence of an altered or defaced number will be considered.

Measures.

5. All wheels offered for inspection must have been measured with a standard tape measure and must have the shrinkage number stenciled in plain figures on the inside of the wheel. The standard tape measure must correspond in form and construction to the "Wheel Circumference Measure" established by the Master Car Builders' Association in 1900. The nomenclature of that measure need not, however, be followed, it being sufficient if the graduating marks indicating tape sizes are one-eighth of an inch apart. Any convenient method of showing the shrinkage or stencil number may be employed. Experience shows that standard tape measures elongate a little with use, and it is essential to have them frequently compared and rectified. When ready for inspection, the wheels must be arranged in rows according to shrinkage numbers, all wheels of the same date being grouped together. Wheels bearing dates more than thirty days prior to the date of inspection will not be accepted for test, except by permission. For any single inspection and test only wheels having three consecutive shrinkage or stencil numbers will be considered. The manufacturer will, of course, decide what three shrinkages or stencil numbers he will submit in any given lot of 103 wheels offered, and the same three shrinkage or stencil numbers need not be offered each time.

*Adopted by the American Society for Testing Materials, Sept. 1, 1905.

Standard Specifications for Cast Iron Car Wheels.
(Continued from Data Sheet No. 13.)

Finish.

6. The body of the wheels must be smooth and free from slag and blowholes, and the hubs must be solid. Wheels will not be rejected because of drawing around the center core. The tread and throat of the wheels must be smooth, free from deep and irregular wrinkles, slag, sand wash, chill cracks or swollen rims, and be free from any evidence of hollow rims, and the throat and thread must be practically free from sweat.

Material and Chill.

7. Wheels tested must show soft, clean, gray iron, free from defects, such as holes containing slag or dirt more than one-quarter of an inch in diameter, or clusters of such holes, honeycombing of iron in the hub, white iron in the plates or hub, or clear white iron around the anchors of chaplets at a greater distance than one-half of an inch in any direction. The depth of the clear white iron must not exceed seven-eighths of an inch at the throat and one inch at the middle of the tread, nor must it be less than three-eighths of an inch at the throat or any part of the tread. The blending of the white iron with the gray iron behind must be without any distinct line of demarcation, and the iron must not have a mottled appearance in any part of the wheel at a greater distance than one and five-eighths inches from the tread or throat. The depth of chill will be determined by inspection of the three test wheels described below, all test wheels being broken for this purpose, if necessary. If one only of the three test wheels fails in limits of chill, all the lot under test of the same shrinkage or stencil number will be rejected and the test will be regarded as finished so far as this lot of 103 wheels is concerned. The manufacturer may, however, offer the wheels of the other two shrinkage or stencil numbers, provided they are acceptable in other respects as constituents of another 103 wheels for a subsequent test. If two of the three test wheels fail in limits of chill, the wheels in the lot of 103 of the same shrinkage or stencil number as these two wheels will be rejected, and, as before, the test will be regarded as finished so far as this lot of 103 wheels is concerned. The manufacturer may, however, offer the wheels of the third shrinkage or stencil number, provided they are acceptable in other respects, as constituents of another 103 wheels for a subsequent test. If all three test wheels fail in limits of chill, of course the whole hundred will be rejected.

Inspection and Shipping.

8. The manufacturer must notify when he is ready to ship not less than 100 wheels; must await the arrival of the Inspector: must have a car, or cars, ready to be loaded with wheels, and must furnish facilities and labor to enable the Inspector to inspect, test, load and ship the wheels promptly. Wheels offered for inspection must not be covered with any substance which will hide defects.

9. A hundred or more wheels being ready for test, the Inspector will make a list of the wheel numbers, at the same time examining each wheel for defects. Any wheels which fail to conform to specifications by reason of defects must be laid aside, and such wheels will not be accepted for shipment. As individual wheels are rejected, others of the proper shrinkage, or stencil number, may be offered to keep the number good.

Retaping.

10. The Inspector will retape not less than 10 per cent of the wheels offered for test, and if he finds any showing wrong tape-marking, he will tape the whole lot and require them to be restenciled, at the same time having the old stencil marks obliterated. He will weigh and make check measurements of at least 10 per cent of the wheels offered for test, and if any of these wheels fail to conform to the specification, he will weigh and measure the whole lot, refusing to accept for shipment any wheels which fail in these respects.

Drop Tests.

11. Experience indicates that wheels with higher shrinkage or lower stencil numbers are more apt to fail on thermal test; more apt to fail on drop test and more apt to exceed the maximum allowable chill than those with higher stencil or lower shrinkage numbers; while, on the other hand, wheels with higher stencil or lower shrinkage numbers are more apt to be deficient in chill. For each 103 wheels apparently acceptable, the Inspector will select three wheels for test—one from each of the three shrinkage or stencil numbers offered. One of these wheels chosen for this purpose by the Inspector must be tested by drop test as follows: The wheel must be placed flange downward in an anvil block weighing not less than 1,700 pounds, set on rubble masonry two feet deep and having three supports not more than five inches wide for the flange of the wheel to rest on. It must be struck centrally upon the hub by a weight of 200 pounds, falling from a height as shown in the table on page 1. The end of the falling weight must be flat, so as to strike fairly on the hub, and when by wear the bottom of the weight assumes a round or conical form, it must be replaced. The machine for making this test is shown on drawings which will be furnished. Should the wheel stand without breaking in two or more pieces, the number of blows, shown in the above table, the one hundred wheels represented by it will be considered satisfactory as to this test. Should it fail, the whole hundred will be rejected.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, MARCH, 1908.
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Falls Rivet & Machine Co., Cuyahoga Falls, O.
Holland Linseed Oil Co., Chicago.
S. Obermayer Co., Cincinnati.
Pyott Core Machine Co., Chicago.

PATTERNMAKERS' MACHINERY.

Fox Machine Co., Grand Rapids, Mich.
Killing Molding Machine Co., Davenport, Ia.
Oliver Machinery Co., Grand Rapids, Mich.

PNEUMATIC RIDDLES AND RAMMERS.

Chicago Pneumatic Tool Co., Chicago.
Hanna Engineering Works, Chicago.

OIL AND GAS FURNACES.

Hawley Down Draft Furnace Co., Chicago.
Kroeschell-Swartz Gyrating Flame Furnace Co., Chicago.
Rockwell Engineering Co., New York.

MISCELLANEOUS EXHIBITS.

Knoeppel Co., Buffalo.
Mitchell-Parks Mfg. Co., St. Louis.
Garden City Sand Co., Chicago.
Ballou's White Sand Co., Millington, Ill.
Goldschmidt Thermit Co., New York.

DIFFICULTIES RESULTING FROM THE EXPANSION OF A HEAVY CORE ARBOR.

By Scribe

I had been but a short time with a firm that made a specialty of cast iron columns when an order was received for several 27-foot columns choked at each end similar to Fig. 1. As this was an extraordinary length, the problem of shrinkage immediately

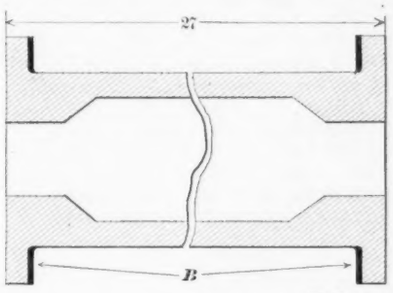


Fig. 1—Section of Cast Iron Column

presented itself for accurate solution. On all other columns which had up to this time averaged 14 feet, I had used the "tenth rule" and allowed but ¼ inch over all for facing, at the same time thickening the back of the flanges ¼ inch for safety, as shown at B, Fig. 1.

With this past experience as a guide, I decided to adhere to the "tenth rule" and allow no extra length whatever for facing, but thickened the flanges ¼ inch as before. Having settled this point, I made a pattern for the core arbor with a section similar in shape to Fig. 2, and along with the core box sent it to the foundry to be rigged up for a green sand core. Two stock column patterns of the proper diameter were then pressed into service and arranged to be stopped off at the proper length. After fastening the various brackets and lugs in their respective places, the pattern was also sent to the foundry, where the mold was made and properly poured.

The next morning, having some misgivings in regard to the shrinkage, I made a rod on which was marked the length of the pattern, also the length of the required casting plus stock for finishing. Thus armed I marched bravely to the foundry.

The casting was uncovered and still cherry red, but with the aid of a helper I applied the measuring rod and to my infinite horror found the casting to be just 1¼ inches longer than the pattern, and about 4 inches longer than the required casting. With the cold sweat breaking out all over me I immediately questioned the foreman, as well as several of the more experienced molders as to the probable cause of the phenomenon, but strange to say there was not a man in the shop able to throw any light whatever on the subject. After racking my feverish brain for a solid half hour for a plausible solution, it suddenly dawned on me that the expansion of the heavy core arbor was causing all the trouble and was entirely responsible for the added length. Confined as it was by the choke at each end, the sand flange and all had been forced by the heated bar to assume the length previously stated.

Confronted by this predicament, nothing could be done except to await anxiously further developments. It is not difficult to imagine what a feeling of indescribable relief and satisfaction I experienced on finding that, having cooled, the casting had shrunk almost exactly what I had anticipated, leaving a good ¼ inch to be planed off each end.

PIN HOLES IN CHILLED CASTINGS.

By Alex. E. Outerbridge Jr.

Pin holes occasionally appear in the white iron tread of chilled car wheels underneath the skin. This defect we traced to gas formed by a film of oil that was rubbed over the face of the iron chill to prevent its rusting, and the method we adopted was simply to rub the chills with a brush containing fine plumbago in its bristles. No oil was used. The graphite gave the chill a polished surface and the pin holes disappeared.

When high chilling iron contains over 0.08 per cent of sulphur, gas holes may be expected at almost any place in the casting. The best method of eliminating these holes is to add about one pound of ground, 80 per cent ferromanganese to 600 or 700 pounds of iron in the ladle just before pouring.

BEARING METAL.

M. C. J. Reed, of Philadelphia, has obtained a patent on an alloy of 85 per cent lead, 10 per cent arsenic and 1 to 5 per cent copper, which is reported to give good results as an anti-friction bearing metal. For bearings for certain uses the proportion of arsenic may be very much greater and may in some cases advantageously be increased to 50 or even 70 per cent. In preparing the alloy, particularly where the proportion of arsenic is relatively high, it is advantageous to melt the elements together in a receptacle while under greater than atmospheric pressure so as to prevent volatilization. For anti-friction bearings the copper may in some cases be dispensed with and the arsenic and lead be combined by melting.

FLUXES FOR SOFT METALS.

The three principal soft metals are lead, tin, and zinc. Mixtures in which there is considerable zinc must be fluxed with sal-ammoniac in the same manner as pure zinc.

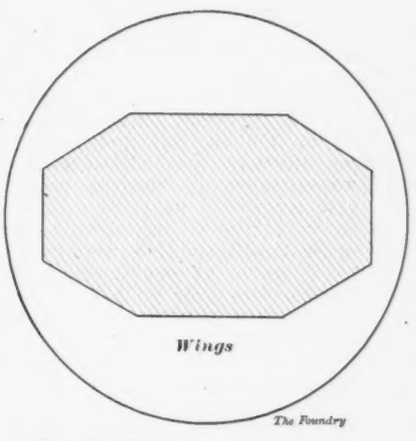


Fig. 2—Section of Pattern for Core Arbor

The subject of fluxes may be summed up in the following table:

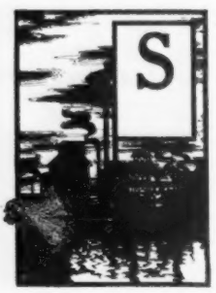
Metal.	Best flux.
Tin	Tallow.
Lead	Rosin.
Solders	Rosin.
Lead Alloys	Rosin.
Tin Alloys	Rosin.
Zinc	Sal-ammoniac.
Zinc alloys	Sal-ammoniac.

In the case of tin or tin alloys, rosin will be found better than tallow for making solder or babbitt metal, but if tinning is to be done, tallow should be employed.

The method of using fluxes on soft metal is as simple as it possibly could be. The rosin, sal-ammoniac, or other flux is sprinkled upon the surface while the metal is melted. No more than is necessary to clean the metal is used. The liquid scum is then skimmed off.—*The Brass World.*

RAT-TAILING AND OTHER DIFFICULTIES EXPERIENCED BY THE SUNNYSIDES FOUNDRY & MACHINE CO.

BY F. WEBSTER



SAM came in from the foundry one morning looking as blue as the flame at the charging door of the cupola when the carbon monoxide flame is making its greatest show or as the blue blazes from a burning mold. "Well, what is the matter now?" said Bennett, as he glanced up from the ledger mixup of debits and credits in the account of the electric railway. "Why, all those stove plate castings spoiled again, and for the third time," replied Sam, as he reached for his pipe and had a sinking spell into the chair behind the office stove.

"What do they look like, anyway?" asked Bennett. "Look just like a dusty road after a family of snakes had treked over, or the top of the meal box from which the rats had made a hasty skidoo." "Rat tails, p-l-y g-o-n-e!" replied Bennett, as he drawled out his favorite swear words; or "snake tracks, if you please," ventured Sam.

It should be explained right here that Sam Butler and Henry Bennett had operated a machine shop at Sunnysides in the saw mill country for a great many years. Sam was married and his oldest daughter taught room No. 6 in the public school, besides she did the fine work on the books of the machine shop during the evenings and Saturday afternoons, when not otherwise engaged. Bennett was a bachelor, who was as shy of the feminine persuasion as the ordinary core room is of light and ventilation. He had become so wary that no bait, whether by budding decollete, or by the debris of former seasons would tempt him to embrace the opportunity. He would hike out, though, each year on a brief excursion to St. Louis or Chicago to visit acquaintances employed in foundries and machine shops. It was during these visits of inspection that he picked up some pointers about molding the patternmaking.

Both men had a large acquaintance list, and in connection with their machine shop work received numerous calls for pot metal castings, not only from the saw mill operators, but from the farmers in the great agricultural district in the North Valley. They also naturally joined with their fellow citizens in the general howl of complaint against the exhorbitant prices charged for repairs, and the losses caused by the exasperating delays in getting them. It was considered a rank injustice and a hold up that forced the paying nearly as much for simple repairs as the first cost of the machine.

So it came about that the foundry attachment to the machine shop was started about the time of the completion of the electric railway in the town, and the Sunnysides Foundry & Machine Co. made its debut with letter and bill heads that required the art editor of the job room, working overtime for a week, to create. The firm also butted into the advertising columns of the local paper, and received complimentary editorials and a vivid write-up when the first castings were poured. They had very little trouble getting started, for fortunately the castings they tried to make were of a kind very difficult to spoil; that is, they did not begin on air-cooled auto cylinders, and they managed to run off heats frequently enough to prevent the sparrows nesting and brooding in the cupola. Troubles were a plenty, however, after they began making, or rather tried to make stove plate, and other smooth work, and our story opens with a dialogue about their first experience with a reliable scrap producer. As the firm already had more dead ones on the vacant lot than could be used, and which came to them almost free of cost, there was no special inducement to manufacture either any scrap or profanity.

After the exchange of sentiments about the rats and snakes, Bennett gazed intently for some time at the seashore chromo on the large calendar hanging on the back of the door. But this time he did not center his attention as usual on the costume of the leading lady in the group of bathers. On the contrary, he saw the long bright parallel lines of sea weed and kelp strung like ropes along the strand, each succeeding wave of the falling tide leaving a new line.

"I wonder," he thought, "if the molten iron acts the same way with the facing on the bottom of our molds, and if this is the cause of the defects in our castings?"

When the next heat was run off for casting some pump handles, anchor plates, and a few rough odds and ends, a mold was made up for a plate using the Wyandott facing in the same way as previously tried, only the mold was left open except at the pouring basin. The Wyandott was their first purchase of facing, as well as their first experience in applying art to molding operations. The agent, who was an ex-dispenser of patent medicines and who sold the facing, claimed that perfect castings could not be made without using Wyandott; that it was a wonderful product made by a patented process owned exclusively by his company. Besides it was dirt cheap and pure as an angel. It contained no impurities, such as silicon, manganese, phosphorus, sulphur or carbon! Many more negative contents were mentioned, but so far neither Sam nor Bennett could find the names of these in the largest dictionary in town. The action of the flowing metal on the facing was equal to nature on the seashore. "There was no bathing suit in it, though," said Sam. "P-l-y g-o-n-e," drawled Bennett, as his observations began to strike in. After making several experiments, Bennett did a very wise thing—and there are a good many regulars who had better sit up and take notice—he sent a letter of inquiry to a reliable foundry supply company, fully stating the trouble, and requesting help and a working sample of the facing they guaranteed for this class of work. For, if the grade of sand used must have a facing in order to produce clean and smooth castings, then it is worth while getting the right kind and to properly apply it in the right place. The letter writing act proved a money-maker, as it led to a settlement of the first difficulty and brought dividends in both cash and cheerfulness. Besides, it opened the way for a successful warfare against the horde of enemies that afterwards attacked the shop, such as the other varieties of rat-tailing or scaming, scabs, blows and shrinkage, as well as the evils that can come so easily from numerous mixtures and peculiar methods of handling.

While there are geniuses in country stores who can produce unlimited tons of perfect castings, and turn them out as easily and cheaply as digging potatoes from the dirt, yet the ordinary foundryman who tries to get within gun shot of his competitors must exercise eternal vigilance to prevent himself from getting into the scrap pile. Especially should the young foundryman cultivate the acquaintance of his best friends—the foundry trade papers, the reliable manufacturer and supply company, reference books or R. F. D. courses of study and he should shun the individual whose chief aim is to kill the ambition and progress of others by constantly declaring that nothing is needed in foundry work but muscle.

A GRAY IRON JOBBING FOUNDRY

Shop of the Hamilton Foundry & Machine Co., Hamilton, O.—Methods of Making Difficult Castings

THE HAMILTON Foundry & Machine Co., Hamilton, O., operates a jobbing foundry for the manufacture of fine gray iron castings. The work, while of a jobbing character, is obtained in sufficient quantity to warrant the adoption of special methods and insure the employment of a pattern for a considerable period. A large portion of the work consists of safe frames, as there are a number of safe manufacturers located in Hamilton who have their work done by the Hamilton Foundry & Machine Co. Other castings made comprise fine picture frames, scale castings, coffee mill parts, desk handles, etc.

Up to a very recent time the molding was done by hand exclusively. Recently, however, six Mumford vibrator machines were installed and experiments conducted with the idea of eventually making a large number of the molds by machine. The machines are installed in what is known as the light work foundry, a general view of which is shown in Fig. 2. It is probable that in the near future this building will be devoted almost exclusively to molding machine work. The main foundry is used for the heavier castings and is spanned by two 10-ton Niles cranes. An extension at one end is used for the making of safe castings, while beyond the safe department is located the cleaning room. The main foundry and light work shop are parallel buildings with the office building, pattern shop, shipping and storage rooms extending across the front, and with the miscellaneous jobbing room joining them, being parallel to the office building and located at about the middle point of the length of the two main foundries.

General Arrangement of the Plant.

The building containing the office, pattern shop and other departments has a frontage on the street of about 250 feet and a depth of 44 feet. The light work foundry extending back at right angles to it is 386 feet long and 60 feet wide. It is one story high, with windows on both sides and in one end, providing ample lighting facilities. Being used exclusively for light work—mostly done at the bench—it has no crane facilities. At about the middle point of its length a two-story extension 26 x 28 feet has been built to accommodate a No. 5 Whiting cupola. Blast is furnished this cupola by means of a No. 5 motor-driven Roots blower installed in the cupola extension. An electric elevator serves to raise the cupola charges to the charging floor.

Special Flasks.

In this building six Mumford vibrator type machines are installed, being located along the left end wall. These flasks embody a unique feature taken up by benches for the molders. With the exception of a few castings, sand matches for which are shown in Fig. 1, snap flasks are used entirely. These flasks embody a unique feature introduced and patented by the Hamilton Foundry & Machine Co. This comprises the raising strip used to increase the depth of the flask. An ordinary snap flask is taken and its upper edges fitted with a metallic facing strip provided with key-hole shaped openings. The raising strips are fitted with buttons which fit into these openings, permitting the raising strips to be readily attached to the flask.

Main Foundry.

The main foundry building is 277 feet long by 100 feet wide. The heavy work foundry occupies the front portion of this building for a depth of 200 feet, the remaining portion being divided equally between the safe department and the cleaning room. The cupola room is located about midway the length of the building on the right hand side and contains two Whiting cupolas, Nos. 6 and 8, respectively. Blast is supplied to both these cupolas by a motor-driven No. 6 Root's blower installed in a brick building located about 50 feet from the foundry. An electric elevator serves to raise the charges to the charging floor. The core room is located on the same side of the building as the cupolas, and contains two coke-fired core ovens, one on either side of the cupola room, each 20 x 28 feet. The core benches extend along the out-

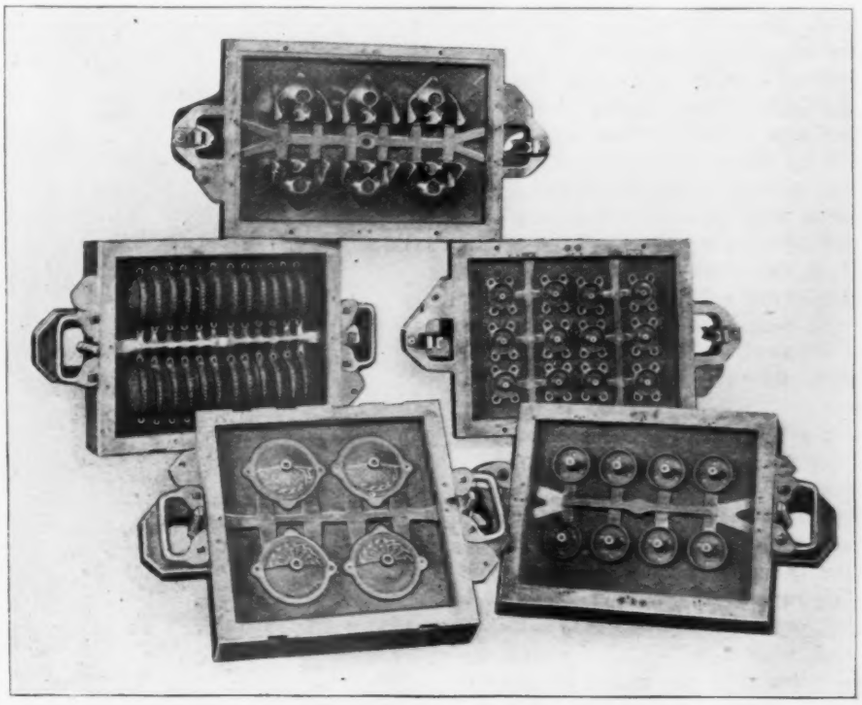


FIG. 1—COMPOSITION MOLD BOARDS FOR A VARIED LINE OF SMALL CASTINGS. THE METHOD OF GATING IS INTERESTING

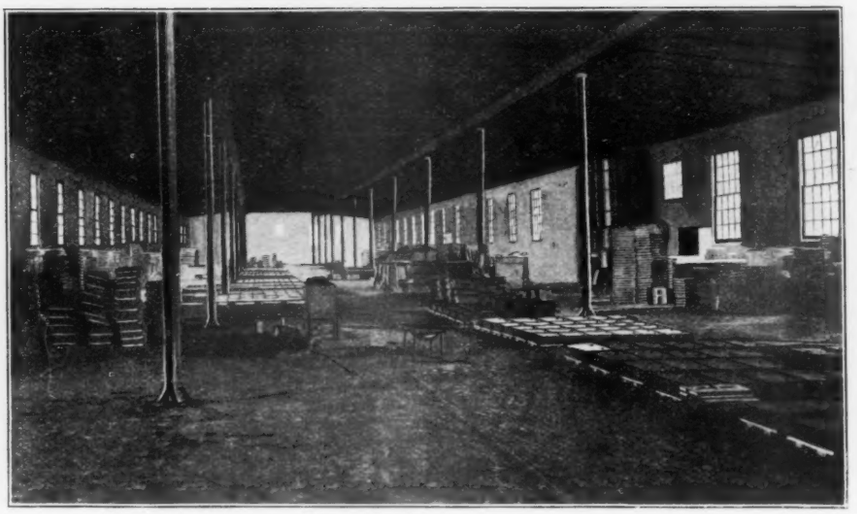


FIG. 2—VIEW OF THE LIGHT WORK FOUNDRY

side wall and two sand mixers are situated opposite the core benches.

Metal is conveyed from the cupolas to the main foundry by means of bull ladles on the cranes which distribute it to hand ladles for pouring individual molds. In the light work foundry it is carried direct from the cupola in hand ladles.

Jobbing Shop.

The jobbing foundry, 86 feet long and 50 feet wide, is devoted largely to miscellaneous bench work, although frequently castings are made here which are large enough to be floor jobs.

The shipping room for the main foundry is located at one end of the building facing the street, and directly in front of the main foundry, being separated from it, however, by a pattern storage and stock room 50 feet wide. The shipping room is 100 feet square and contains ample facilities for packing, loading and weighing the castings. The pattern storage between the shipping room and main foundry is 50 x 40 feet and of fireproof construction. On the opposite side of the building is a storage and stock room of the same dimensions providing a 10-foot passageway between the main foundry and shipping room. Adjoining the shipping room is the light work shipping room, 51 x 44 feet, with the exception of a space 20 x 16 feet which has been walled off from it and used for office purposes. The shipping room opens directly upon the pickling and tumbling room. Adjoining the light shipping room is a repair shop which is fitted with a full equipment of machine tools for the repair of patterns and machinery parts for the foundry. The patternmakers' room adjoins the repair shop, and is used principally for the mounting of the metal patterns, which are largely used throughout the shop. A passageway, 5 feet 10 inches, separates the patternmakers' room from the metal pattern storage, which is 44 x 31 feet.

Two tumbling rooms, one with 24, the other with 12 tumbling barrels, comprise the tumbling equipment of the plant. One of these is installed in the frame building behind the light pattern storage and is shown in Fig. 4. An efficient system of dust removal is provided in this room, an exhaust fan removing dust from the barrels through the system of piping shown, and depositing it in a dust catcher at the end of the room, whence it can be removed as desired. Two pickling vats are also situated in this room. The other tumbling room is in a building situated about 30 feet from the heavy work shipping room, which contains also a pattern storage and a repair shop. This building in dimensions is about 100 x 50 feet, and is divided into three parts for the three departments which it contains. A frame building divided into appropriate bins for sand storage is located on the same side of the main foundry as this building, as is the brick blower house containing the cupola blowers.

A Laidlaw-Dunn-Gordon duplex air compressor, 11 x 32 inches and two stage, provides the compressed air for the cleaning department and molding machines. This is situated in an extension built on to the cleaning room.

Computing Scale Casting.

Extremely intricate castings are made in this foundry, and sometimes by rather unusual methods. The one shown in Fig. 5 is a casing for a computing scale. The illustration shows the front, back and bottom respectively of three castings, illustrating the extensive amount of core work which has to be done. Fig. 3 shows the mold for these castings, the drag being at the right of the illustration. The core is of green sand and is supported by means of the sand projections through the openings shown in the front and back of the castings. A two-piece pattern is used in a single parting flask. It would naturally be

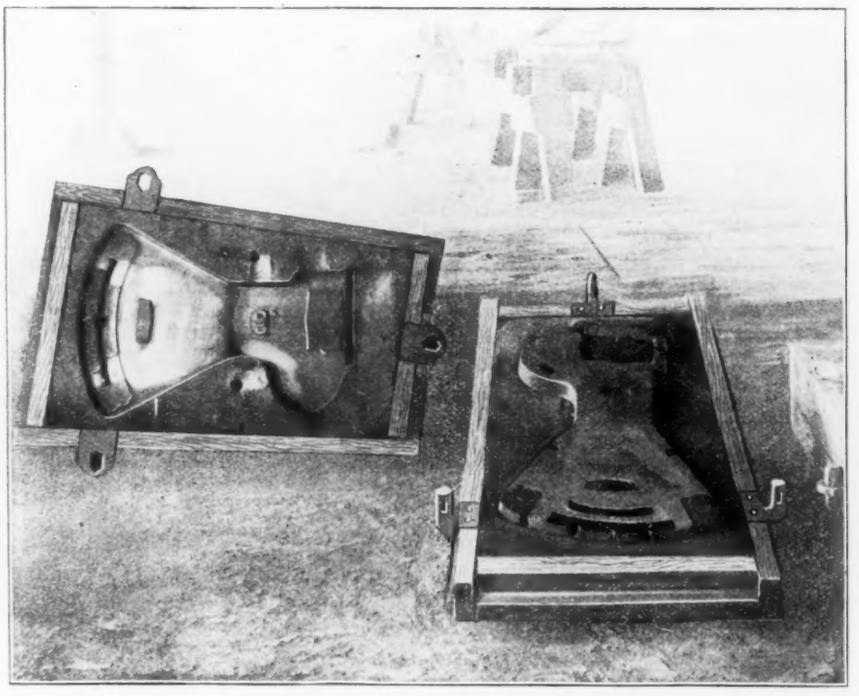


FIG. 3—DRAG AND COPE OF A COMPUTING SCALE MOLD

supposed that a core of this size, in proportion to the size of the casting would be baked, but the green sand has proved amply satisfactory, and the percentage of losses is low. As the core is supported at many points, as can be seen by reference to the illustration, the mold is not as difficult to handle as might be supposed.

Other molding jobs worthy of note are those made on the machines, comprising coffee mill parts, caster housings, caster wheels, desk handles, etc. The patterns are mounted in vibrator frames, properly gated by the company's patternmaker, and an oil and sand match is prepared for use in the machine. As previously stated, snap flasks are used almost exclusively. Practically all of the machine patterns are of metal, bronze being mostly used. Their quantity is such that a metal patternmaker is employed constantly in repairing and mounting them. Another interesting casting made is the outer shell of the crushing part of a coffee mill. The method of molding this is shown in Fig. 6. On opposite sides of this shell are two rectangular openings as shown. The core for this is made of green sand, and half of this is on the cope and half in the drag. The parting line of the core is shown in the illustration, and its position is such as to enable the molder to ram up and withdraw the pattern exactly as if it were a simple conical piece without openings.

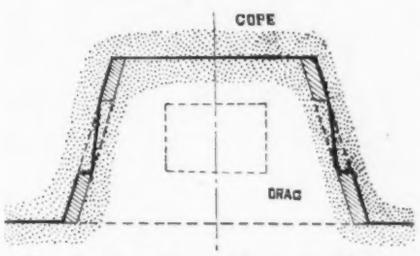


FIG. 6—PARTING OF MOLD FOR COFFEE MILL SHELL

The power plant is contained in a separate building. The equipment comprises two 125-horsepower Atlas water tube boilers, and a 225-horsepower Hamilton Corliss engine direct-connected to an electric generator. The officers of the company are: G. A. Rentschler, president; G. S. Rentschler, vice president; H. A. Rentschler, secretary and treasurer, and J. W. Young, superintendent.

FIG. 5—COMPUTING SCALE CASTING

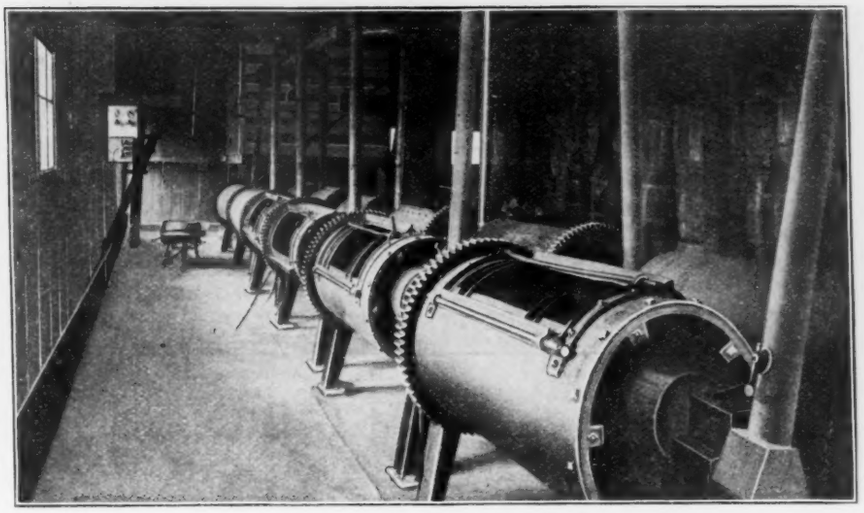


FIG. 4—ONE OF THE TUMBLING ROOMS

NEW ENGLAND FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the New England Foundrymen's Association was held with 50 present at the Exchange Club, Boston, Feb. 12. The Waterbury Castings Co., Waterbury, Conn., was unanimously elected to membership.

The committee on shortages submitted a report of the proceedings transacted at the conference held in Philadelphia, Feb. 5, the report being read by J. L. Anthony, chairman.

Vice President Wm. A. Viall was called upon for remarks regarding his visit to the "tri-party novelty dinner" tendered by the Philadelphia Foundrymen's Association recently and he spoke very highly of the interesting program provided and the hospitality and courtesies extended to the visiting members. A hearty resolution of thanks to the Philadelphia Foundrymen's Association for courtesies extended to the members of the New England Association at the dinner, was adopted.

The meeting then adjourned to dinner, after which the president introduced as the speaker of the evening, Hugh Kennedy, general manager of the Buffalo & Susquehanna Iron Co., who gave an illustrated talk describing the operation of blast furnaces using northern ores

Announcement was made that the March meeting would be held in Boston and the meeting would be addressed by Joseph Jeppson, superintendent of the Norton Co., Worcester, on "The Emery Wheel and Its Application to Foundry Work."

METALS IN FOUNDRY PRACTICE

Questions from Practical Foundrymen are answered
in this department by the following experts

CAST IRON	W. J. KEEP
MALLEABLE IRON	DR. RICHARD MOLDENKE
METALLURGY OF STEEL	J. B. NAU
STEEL CASTINGS	W. M. CARR

OTHER EXPERTS ALSO CONTRIBUTE — ADDRESS ALL INQUIRIES TO THE EDITOR

CAST IRON NOTES

BY W. J. KEEP

QUESTION:—We are having trouble with the small castings that we are making. Our cupola is a No. 8 Whiting, lined up to 54 inches. We have been charging the bed coke 18 inches above the top row of tuyeres. On this we charge 2,500 pounds of iron, then 200 pounds of coke, and 2,000 pounds of iron. Our blast pressure ranges from 14 to 16 ounces, but our iron is not sufficiently hot for our purpose. We have recently increased the bed charge to about 24 inches above the tuyeres, with the same blast, and have increased the coke to 300 pounds for each 2,000-pound charge of iron. We use 30 pounds of limestone with each charge. Our iron mixture is as follows: No. 1 pig iron, 100 pounds; silicon, 7 per cent; sulphur, 0.075 per cent.

No. 2 pig iron, 1,200 pounds; silicon, 2.29 per cent; sulphur, 0.025 per cent; manganese, 0.83 per cent.

No. 4 pig iron, 700 pounds; silicon, 1.60 per cent; sulphur, 0.027 per cent; manganese, 0.84 per cent.

The coke contained about 0.8 per cent of sulphur. The castings were pitted, and contained small particles in these holes. The slag skimmed from the top of the ladle had a graphitic appearance, similar to the particles in the pits of the castings. The fracture of the castings also had a similar appearance, not only at the bottom, but at the top as well. We do not experience this trouble with our heavier castings, however. We add ferro-silicon to the ladle when pouring the small castings, and ferro-manganese for large castings that are to be finished. Kindly advise us how we can overcome these difficulties.

Answer:—The mixture, provided all pig iron were used, would contain 2.25 per cent of silicon, which would be the proper content for large castings, but would not be sufficient for small sections. It would also be necessary to use the scrap made in the shop. Ordinarily machinery scrap would be used to cheapen the mixture and to give a close grain. This would have the effect of reducing the silicon content.

Do not change the silicon in the mixture for the larger castings, but increase it to 2.75 per cent for the smaller ones. If your heats are small, close the upper row of tuyeres and charge the bed coke two feet above the lower tuyeres, although 18 inches should be sufficient. Your method of charging is correct, although the first iron charge should be about 2,000 pounds. There is no reason why your iron should not be hot, providing you are weighing your mixtures carefully and the chemical composition is as you have stated. The iron containing 7 per cent silicon is not a No. 1 grade, but is a silvery iron and is just as good as ferro-silicon to soften your castings. You should use the silvery iron at all times to soften the light castings, but you will have trouble with them unless you melt your iron hot. Ferro-manganese is not required for such irons with the grade of coke that you are using, as you have very little sulphur to remove. Until you can get your iron hot enough to give you solid castings, use a small piece of pure aluminum in each ladle to remove the pitting.

HIGH SULPHUR IRON.

Question:—Does the term 60-inch cupola apply to the shell or to the inside diameter of the lining, and if the latter, would this diameter be at the tuyeres or at the melting zone? What should be the area of tuyeres in a cupola 50 inches in diameter at the tuyeres, and, provided they are 15 inches above the bottom, would 1,800 pounds of coke be the proper amount for the bed, if the fire is started two hours before the blast is put on? Have the standard specifications for foundry iron been generally adopted, so that No. 2 grade contains 2.25 per cent silicon and 0.045 sulphur? Would the addition of an iron having an excessive amount of manganese drive the sulphur into the slag if the iron contained 0.085 per cent of sulphur, or would the addition of silicon or manganese alloys remove it?

Answer:—More care should be exercised in designating the size of the cupola. If you were to order a 60-inch cupola you would undoubtedly receive a furnace with a 60-inch shell, but as the linings vary from 5 to 9 inches, the diameter inside of the lining at and above the melting point should be known. Unless otherwise stated, the cupola would be considered straight inside. The weight of the coke bed would depend largely upon the use of one or two rows of tuyeres. Most of the furnaces now in use have two rows. The coke, one and one-half hours after lighting, should reach 18 inches above the upper tuyeres, and the proper amount to use can be ascertained by experiment. With a 52-inch lining and two rows of tuyeres, I use 1,600 pounds of coke on the bed and charge 3,000 pounds of iron. The succeeding charges consist of 260 pounds of coke for each charge of 3,000 pounds of iron. It is advisable to break the scrap into small sections to charge evenly, and to begin with plenty of coke and then reduce the coke bed 25 pounds and the succeeding charges 10 pounds until the proper amount has been reached. For small castings the proper melting ratio is about 9 to 1. You must have hot iron to avoid blow holes.

The standard specifications for foun-

dry iron are based on a general practice which provides for no less than 2.25 per cent of silicon in a No. 2 iron and other elements as given in these specifications. If a grade is offered as No. 2 with a smaller percentage of silicon, the same price should not be paid for it as standard No. 2. It is also advisable to refuse irons higher in sulphur than the standard calls for. You would rarely have 0.085 per cent sulphur in any of your scrap except stove plate, and this limits the amount of such material that you can use. Manganese in any form will reduce sulphur slightly, but it is advisable to keep the percentage low in the charge. Silicon will not remove it entirely, but will counteract it to some extent. Make the lower row of tuyeres about 4 inches high and flare them on the inside to make the openings as nearly continuous as possible.

HARD IRON FROM A SMALL CUPOLA.

Question:—Our cupola is lined to 32 inches and we charge 40 pounds of coke to 500 pounds of metal. We use 25 per cent of pig iron containing 3.10 per cent silicon, 25 per cent of another with 2.80 per cent silicon, and 50 per cent of machinery scrap. We make agricultural and machinery castings, which are too hard for our use.

Answer:—If your scrap averages 1.75 per cent silicon, and this is a sufficiently high estimate on account of the sulphur that it contains, your castings would have 2.35 per cent silicon, which is not enough. Add enough silicon iron to make the silicon 2.50 per cent or try one heat with 50 per cent of the iron with 3.10 silicon and 50 per cent scrap. You fail to state what you do with the scrap iron that you make.

Increase the silicon until your castings are soft, as it is probable that the analyses you sent do not exactly represent the irons you are now using. While you do not state the amount of coke you put on your bed, you are not using enough on the other charges. Use at least 50 pounds or probably 60 pounds to melt the iron hot and to drive out the sulphur.

CHILLED CASTINGS.

By Alexander E. Outerbridge Jr.

Question:—We would like to make chilled castings ranging in size from ⅜ to ½ inch, with the chill ⅛ of an inch thick, casting the iron against a chilling surface. The analysis of the iron we are now making is as follows: Silicon, 2.20; sulphur, less than 0.06; phosphorus, less than 0.50 and manganese 0.40 to 0.60. At the present time we secure the desired chill by the addition of mold board scrap, and ferro-manganese, but would like to discontinue the use of this scrap by the use of some ferro alloy in the ladle. What would be the result of the addition of a small amount of ferro-chrome? We added 2¾ per cent manganese to this iron but failed to secure any chilling effect when it was added in the ladle. After reheating for 20 minutes we had a complete chill, due to the conversion of all the graphite.

Answer:—The analysis given shows that the silicon is too high, about twice what it should be to produce a chill ⅛ of an inch thick, casting the iron against a chilling surface. The addition of scrap will not cause iron to chill unless the silicon in the scrap is much lower than 2 per cent. Powdered ferro-manganese added in the ladle does not increase the chill; it has the opposite effect. The value of 80 per cent ferro-manganese added in small quantities to the ladle of chilling iron suitable for car wheels just before pouring is, that it immediately acts as a de-oxidizing and desulphurizing flux, thereby greatly increasing the strength and elasticity of the casting, which enables the wheel to withstand shocks that would otherwise cause it to break.

I do not believe that the addition of a small amount of ferro-chromo to a mixture containing 2.20 per cent silicon would have any beneficial effect. The only practical way to obtain the desired result is to reduce the silicon in the mixture to about 1.25 per cent, or lower, if necessary. The statement that the castings range in size from ⅜ to ½ inch is indefinite. Presumably, this means thickness, but the width and length are equally important factors. The smaller the casting, the more readily it will cool and the deeper the chill.

You say in conclusion "We added 2.75 per cent manganese to this iron, but failed to secure any chilling effect when added in the ladle." This was to be expected, but the final statement "after reheating for 20 minutes we had a complete chill, due to the conversion of all the graphite" is very indefinite.

FERRO-SILICON FOR MALLEABLE HEATS.

By Richard Moldenke

Question:—Would the addition of 50 per cent ferro-silicon to charcoal malleable in the proportion of 1 to 40 make first class malleable castings?

Answer:—As no further data as to the compositon of the charcoal iron are given, and the melting process is not mentioned, it is hardly possible to answer the question. However, a few words on ferro-silicon in the malleable foundry will not be amiss. Every foundry should have this material, but should not use it except as a last resort to save a heat. Whenever it becomes necessary to increase the silicon in the bath to cure "high" iron, the metal has already been spoiled for the highest grade of malleable. To add ferro-silicon to a mixture when charged into the furnace, seems unwise, as the silicon is better introduced by means of higher silicon pig. Thus for the normal malleable foundry the silicon of the irons will run from 0.75 up to 1.75 per cent. It is better to use more of the latter when silicon is to be added, than to use the lower ranges and make up with ferro-silicon. The lower the silicon in the pig iron used the greater the chances for burning in melting, hence, as in gray iron practice, the desirability of putting into the cupola or furnace, metal as nearly the composition of the castings wanted as possible, allowing for the loss in melting.

There is no reason, however, why a foundry should not make the lower silicon metal for its heavy range of work, and add say 75 per cent ferro-silicon to the ladle of metal when the very light castings are to be poured. The latter method would, however, only pay in larger plants where heavy work is the rule and a limited amount of small castings must be cared for.

On general principles I would not advise adding high grade ferro-silicon to the original mixture, as this would mean very low silicon pig irons to balance up. This always means rather poor castings, even in the case of charcoal irons.

FLUX FOR SASH WEIGHT IRON.

By W. J. Keep

Question:—What is the best flux to use for melting sheet iron and steel with one-half stove plate for making iron suitable for sash weights?

Answer:—By the addition of a small amount of comparatively high silicon iron you would give your iron fluidity and a little powdered ferro-manganese in the ladle would also help. Fluor-spar would be the best flux to make the slag fluid.

CRUCIBLE STEEL CAR WHEELS.

To the Editor:—We would like to know the chemical analysis of crucible cast steel suitable for making small car wheels which must be tough and will have to withstand hard wear.

FOAMING SLAG.

By W. J. Keep

Question:—How can we overcome the foaming of slag when the blast is about half off?

Answer:—By increasing the coke during this part of the heat.

USE OF METAL CORES IN THE FOUNDRY

Metal Cores Which Chill the Casting to Only a Very Slight Extent Are Described in this Article

BY GEORGE BUCHANAN

METAL CORES are in every-day use in many foundries, but their sphere of usefulness is limited and is usually confined to round tapered cores for plow and other implement wheels. Other shapes than round are sometimes used, all, however, are provided with a little taper to enable the core to be driven out of the casting when cold. These cores are generally known as chill cores and many shapes are in use for the local chilling of castings, such as plow points and other wearing parts, while in some few cases the whole mold is made entirely of metal as in the case of the sash weight plant recently illustrated in THE FOUNDRY, while the chilled car wheel offers perhaps the best example of the local chilling of castings.

All the above chill cores are useful in two particular directions, that is, in their chilling effect on the castings and the fact that they can be used again and again. For the latter reason they are sometimes called permanent cores or molds and there is no doubt that a great deal of experiment is at the present time being devoted to this part of the foundry business.

Metal Cores Without Chill.

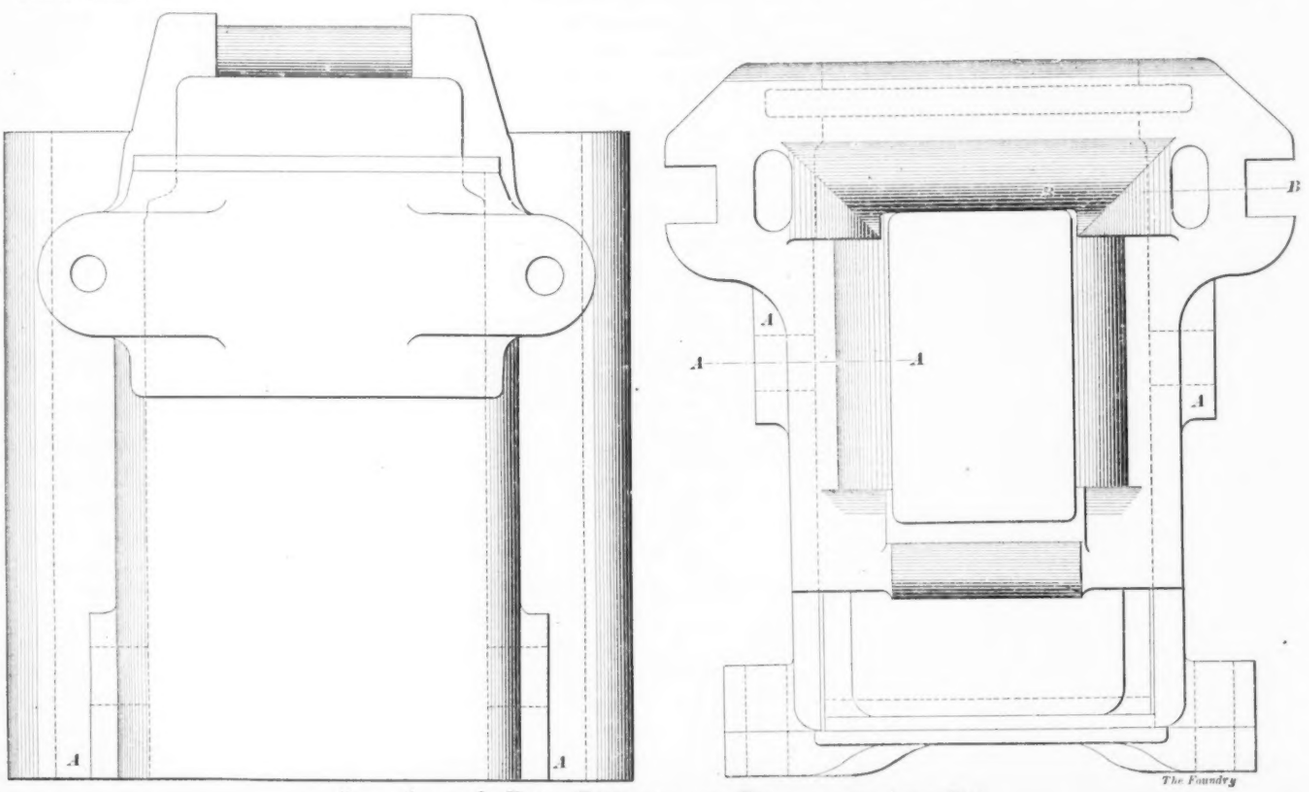
The use of metal cores which do not chill or which do so only to a very slight extent will be described in this article. The advantages which are to be obtained from these permanent cores are many and an example will be given in which their labor saving capacity is shown.

The preparation of the metal cores for use in molds is simple and consists of warming the cores in the oven and painting them with a mixture of boiled linseed oil and plumbago. The cores will dry out in a few minutes, and are then ready for use. The plumbago is mixed with the oil and the paint is used a little thicker than the ordinary blacking. With this mixture the chilling appears to be very slight, but as the cores are not large which have been used up to the present time and the casting fairly heavy, a certain amount of annealing takes place in cooling, favoring the non-chilling of the cored parts. The difference, however, between a painted core and one without is considerable, and for the class of casting on which the cores are used no objection is raised to a slight chill. The thickness of the metal cores is kept between ¼ inch and ⅜ inch, except, of course, in the case of round cores, so that they occupy but little space in the flasks, and for this reason alone possess advantages over ordinary cores which would have to be made in many instances at least 1 inch thick, to permit of handling and to prevent breakage.

Molding an Axle Box.

Figs. 1 and 2 show the front elevation and plan views of an axle box. Fig. 3 shows the casting in two parts—box and grease chamber. At AA a boss is shown having a 1-inch cored hole. The posi

Editor's Note.—This article was awarded second prize in the contest conducted by THE FOUNDRY.



FIGS. 1 AND 2—FRONT ELEVATION AND PLAN OF THE AXLE BOX

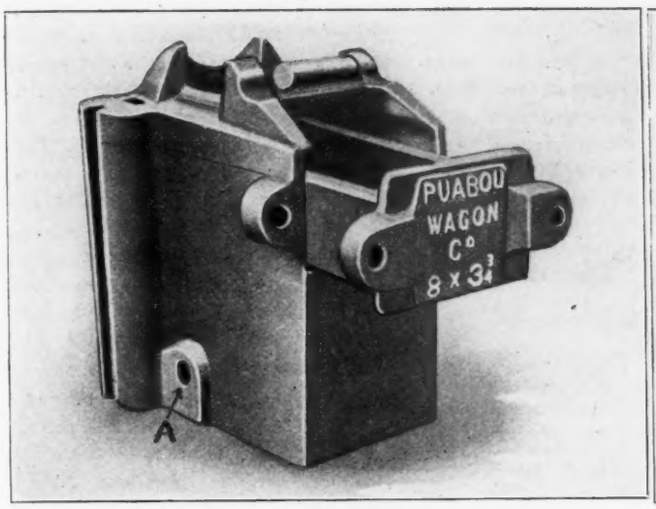


FIG. 3—THE CASTING

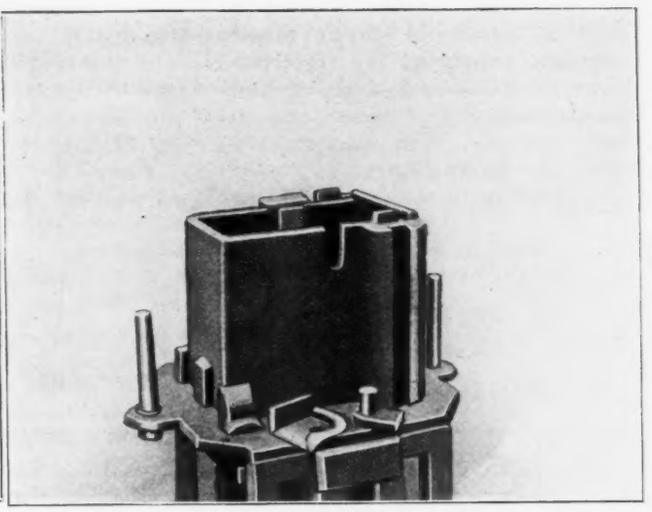


FIG. 5—COPE MOUNTED ON STRIPPING PLATE MACHINE

tion of the bosses AA on the casting make this piece a three-parted job. By the use of the metal cores it was converted into an ordinary two-parted job and is made as rapidly as other boxes which are without these bosses and holes.

The cope pattern mounted on a stripping plate machine is shown in Figs. 4 and 5. In the latter one set of cores is shown placed in position on the pattern and the other pair are shown on the joint of the machine. The front view of the pattern, Fig. 4, partly in section, shows the cores in position at CC and D is an outside view of the same.

Fig. 6 shows sectional views of the mold complete. The sections AA show the metal cores DD in their position in the mold forming the D boss and hole. Since using these metal cores over 2,000 boxes have been made and the cores are still in good condition. They are, however, made as cheaply as ordinary bench castings and receive only the usual dressing before being used as cores.

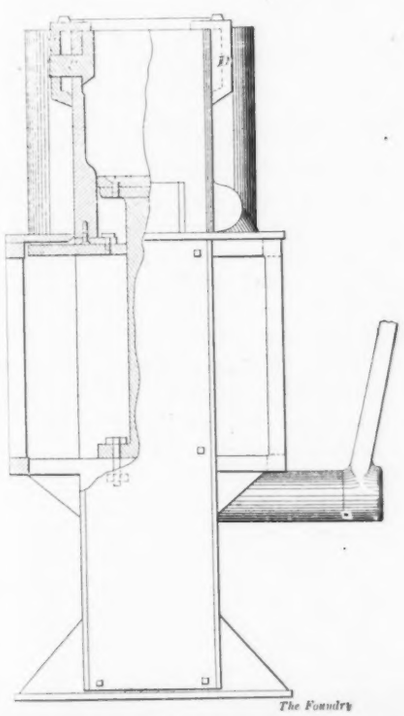


FIG. 4—FRONT AND SECTIONAL VIEWS OF PATTERN ON THE MOLDING MACHINE

The Grease Chamber Casting.

The grease chamber casting is shown in Fig. 3. Two cored holes are shown that serve to bolt the piece to the main casting. The application of the metal core in this instance does away with special cores having draw print attached. Fig. 7 is a front view of the pattern mounted on a stripping plate machine, Fig. 8 is a side view. The metal core is shown at H in its place covering the slot in the pattern. At K the slot is shown. A piece of ordinary stock core is placed in the slot and then the metal covering core H is attached, and the mold rammed in the usual way.

Fig. 9 is a view of the bottom part of the mold rammed up, the dotted lines indicate the position of the cope, which, after being rammed is placed directly onto the drag without having to be turned over, the two round cores being already in position by the aid of the metal cores. A large number of molds are gained on a day's work when the parts can be lifted directly from the machine to their matching parts on the floor. This condition is obtained in this instance by the use of metal cores.

SAND FOR HEAVY BRASS CASTINGS.

BY C. VICKERS

Question:—What grade of sand should we use to obtain the best results in molding patterns for brass castings that will weigh about 500 pounds each?

Answer:—A No. 2 grade is about the best for such work.

PHILADELPHIA CONFERENCE ON SHORT WEIGHTS.

Short weights in shipments of coke and pig iron, from which the foundry interests of New England have especially suffered, were discussed at a conference held at the Bellevue-Stratford, in Philadelphia, Feb. 5, between members of the Philadelphia, New England and Pittsburg Foundrymen's Associations, and representatives of the various railroad and steamship lines most interested. These latter included the Pennsylvania, Reading, New York Central, Baltimore & Ohio, Norfolk & Western and the Buffalo, Rochester & Pittsburg railroads and the Merchants' and Miners' Transportation Co. and the Tennessee Coal, Iron & Railroad Co. Henry A. Carpenter, of Providence, R. I., presided, and several hours were spent in an amicable and earnest dis-

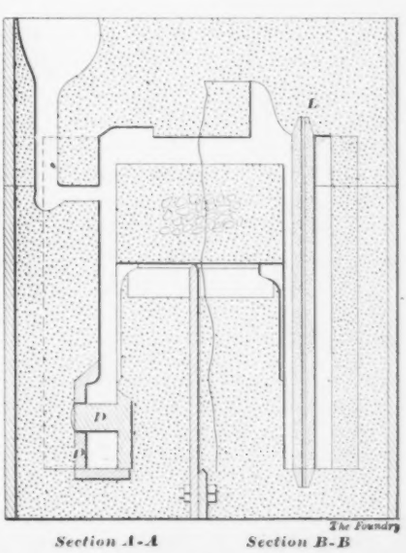


FIG. 6—SECTIONAL VIEWS OF THE COMPLETED MOLD

cussion of the questions involved and the best way of remedying existing conditions. Some of the foundrymen complained that their losses on shipments ranged from three to six per cent, and in a year aggregated as much as $6,000. After the points at issue had been thoroughly discussed, a resolution was adopted providing for the appointment of a committee representative of the water and rail transportation and pig iron, coke and coal interests involved, for the purpose of considering discrepancies in weights of shipments and to report to Chairman Carpenter in writing. It developed during the discussion that some founders, for a great many years until a year or so ago, have been buying iron on a basis of an allowance of 28 pounds per ton sandage plus the English 2,240 pounds gross ton, or 2,268 pounds. The larger transportation interests represented said that they have been shipping 2,240 pounds per ton for the last five years. The consensus of opinion expressed by the majority of the foundry interests represented at the meeting seemed to favor the establishment by transportation companies of scales at ports and points of receipt and subsequent delivery as tending to fix the responsibility for shortage in transit. Objection was made to this by the transportation interests on the ground of increased expense, lack of room and consumption of time in handling.

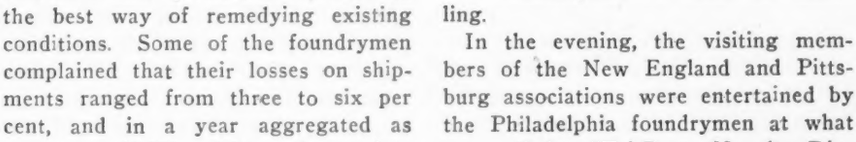


FIG. 7—FRONT VIEW OF PATTERN

In the evening, the visiting members of the New England and Pittsburg associations were entertained by the Philadelphia foundrymen at what was called a "Tri-Party Novelty Dinner," at the Manufacturers' Club. A committee of the hosts appeared dressed as chefs and waiters and showed their skill in waiting upon the guests. Those who arranged the dinner in this unique fashion and carried it through very successfully were: J. H. Sheeler, A. A. Miller, T. M. Eynon, Edgar S. Cook, W. H. Ridgway, H. L. Haldeman, J. S. Stirling, E. H. Mumford, Arthur Simonson, Josiah Thompson, H. L. Tripple and Frank King. Howard Evans, secretary of the Philadelphia association, acted as toastmaster and speeches were made by W. A. Viall, of Providence, president of the New England association; Herbert E. Fields, president of the Pittsburg association; Thomas Devlin, president of the Philadelphia association; H. A. Carpenter, of Providence, R. I.; W. G. Breen, of Boston; B. M. Shaw, Watertown, Mass.; A. M. Abbe, New Britain, Conn.; and John Birkinbine, of Philadelphia.

The following resolution offered by W. S. Hallowell, of the Harrison Safety Boiler Works, seconded by Thomas Devlin, president of the Philadelphia Foundrymen's Association, was unanimously adopted at the dinner:

Resolved, That it is the sense of the Philadelphia Foundrymen's Association that we recommend to the manufacturers of pig iron that they take united action for the purpose of establishing a minimum rate for certain standard grades of pig iron at fixed delivery points so that foundrymen may rely on the basis established for the purchase of their supply.

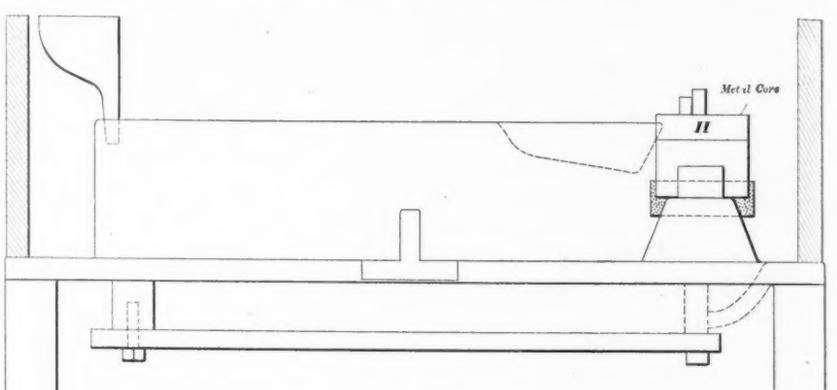


FIG. 8—SIDE ELEVATION OF COPE PATTERN

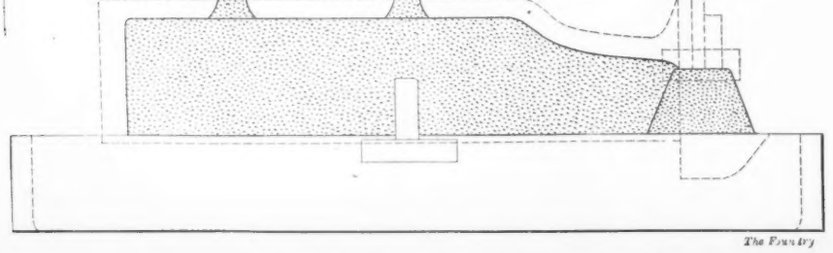


FIG. 9—DRAG OF THE MOLD

CHAIRMEN OF CONVENTION COMMITTEES.

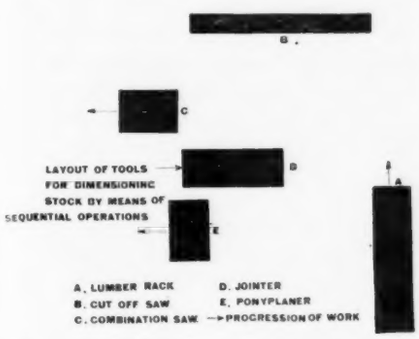
Preparations are going forward in connection with the holding of the convention of the American Foundrymen's Association in Toronto in June and representative committees are being organized.

The following chairmen of committees have been appointed: Entertainment, Frederick Somerville, Somerville Ltd., Toronto; finance, Peter McMichael, Dominion Radiator Co., Toronto; press, W. W. Near, the Page Hersey Co., Guelph; grounds and buildings, Robert Cluff, King Radiator Co., Toronto.

A FEW SUGGESTIONS FROM A PRACTICAL PATTERNMAKER.

By L. B. Ackboy

I have read many of the books and articles on patternmaking and many of them are very amusing. The two ideal pattern shop layouts shown in the February issue of The Foundry are dreams of inaptitude. First of all, there are no lumber racks. We stand our lumber on end three months and then rack it on edge. In another rack we have planed to gage every thickness from 1/16 to 1 inch in pieces 6 feet long. The first operation is to cut the plank, carry it to the cut-off saw and dimension it for length. No cut-off saw, however, is shown in either of these layouts. The workman presumably carries this plank to the cross cut saw which is in line with and only 6 feet from the universal saw. Suppose he has a 14 or 16-foot plank to cut—it will be impossible for him to do it, as he will lap the other saw. Again, it will take one helper at each end of the plank, with the sawyer at the machine. With



Layout of Tools for Dimensioning Stock in the Pattern Shop

the cut-off (swing) saw he dimensions it easily single handed. The next operation for the patternmaker is to rip his billets, so he has to lift and carry them again over to the rip saw, instead of having that tool exactly where his billets leave the cross cut.

Three band saws are shown—I wonder what for—and no jig saw, one of the handiest tools ever put into a pattern shop. The next operation is to plane the piece out of wind and square up the edges on a jointer. Two "buzz" planers are shown. The patternmaker can take his choice. In either case he carries the material at least 50 feet at 40 cents an hour. I am no draftsman, but roughly show the location of some of our tools in the accompanying illustration. My boss would have "locomotor melancholia" sure if just in the operation of getting out dimension stock a skilled patternmaker had to carry lumber more than 300 feet, as in this "model" layout. This would soon run into long measure, furlongs and miles.

Where does the author hope to get a room 80 x 120 feet for a pattern shop? He shows six lathes; ditto, two core box machines. What are they for? To work up straight semi-circular core boxes out of wood? That practice is obsolete with us. Our foundry has a core machine and all sizes are carried in stock up to 3 inches in diameter. Anything complicated with round cores we develop from core sticks, using the core itself as our basis and making the box in cast white metal, which is twice as good—five times as cheap. As for large cores, we make them by sweeping up cement, really reinforced concrete construction, hard as iron, smooth as marble. We can shove the whole thing into the core oven if necessary, using the box as the core pan.

We have a non-shrinkable metal that we use for our core sticks and master core parts. It consists of lead, 69½; antimony, 15½; bismuth, 15. Sometimes the boss adds some kind of dope to this mixture and gets an alloy that expands instead of contracts in cooling. In this way he can get a working pattern from any old casting.

Where does the author make his plate and molding machine work? About one-third of our shop is fitted up for this line of work. What would he do with a multiple mold, five deep, seven on the radial, each weighing 19 pounds? If he has facilities for this very important new work it must be disguised as "segment table" or "segment press."

COMMERCIAL PIRACY

LESS THAN a year ago, a large builder of hydraulic machinery received an order for a hydraulic press of special design. Owing to the keen competition that developed for the order, the contract price was only a trifle higher than the cost of the standard machines of the same capacity. To meet the specifications, which were unusually severe, a press of an entirely new type had to be developed at an enormous expense for experimental work, drawings and an entirely new set of patterns.

When the order was taken, this greatly increased cost was not considered, but upon the completion of the machine, it was found that a tool had been evolved for which a market could be developed with no less than a dozen manufacturers and the loss on the first, it was believed, could be spread over subsequent sales. The future, unfortunately, was not discounted, and up to the present no further sales of presses of this type have been made.

Yet the largest competitor of this concern has sold no less than 10 similar machines at a price far below that at which the original manufacturer could hope to compete. Every detail of the press had been copied, and within a month after the first builder had made his shipment, the salesmen of this formidable competitor were offering a similar tool for early delivery. An immediate investigation was instituted and after all hopes of solving the mystery had vanished, it was learned by the merest accident that an obliging yardmaster had sidetracked the flat car containing the press alongside the works of the competitor. This opportunity was not lost. A force of engineers was set to work making rough sketches and taking measurements, and in less than a month the patterns for the copied machine were in the foundry. No time was devoted to costly experimental work, as none was necessary, this having been done by the magnanimous designer of the original machine.

Notwithstanding the reprehensible conduct of the competitor, the designer and builder of this press had no legal redress; he was only another victim of one of the many forms of insidious thefts that are costing American manufacturers thousands of dollars annually. In the eyes of the law moral larceny is not punishable, and unlike the marauder whose acts lie within the pale of the statutes, the operation of the so-called moral plunderer are more subtle and are carried out with a great show of respectability. In this way, the good names and reputations of old established concerns, as well as their product, if not patented, are appropriated. The concerns are copyists in every sense of the term, and more plainly speaking—commercial pirates.

Another incident shows to what extremity some of these concerns will go to deceive the unsuspecting consumer and lead him to believe that he is securing the genuine instead of the spurious and generally a much inferior article. For many years, a manufacturer of foundry equipment has specialized in one line and has developed this machine to a high state of

efficiency. The patents covering the original are about to expire, but improvements have been made from year to year at a great cost and only a few features of the original invention are still embodied in the machine. The designer, through long experience, has a comprehensive idea of the requirements of a machine of this type for foundry use. He has made it his life's work, and consequently, a subject of special study and experiment. Notwithstanding his good name and enviable reputation in the trade, he is threatened with the loss of a large amount of business to a copyist, who, owing to his lack of originality and hazy knowledge of the special requirements, has flattered the legitimate builder by preserving some of the features of the original. To sell the machine at a price below that asked for the standard it is said that in construction it is inferior to that of the original and the material entering into it has also been slighted. As in all similar cases, a lower price is resorted to as a potent lever to delude the consuming public, with the added assurance that the original would be duplicated. The difference in cost barely represents the difference in quality, while the unscrupulous builder aims to reap the benefits of years of costly experimental work and thousands of dollars expended for advertising.

The copying of catalogs is another attempt at deception that has recently been noted. Not only in size, but in the arrangement of illustrations and text matter does the book of this copyist closely follow the original.

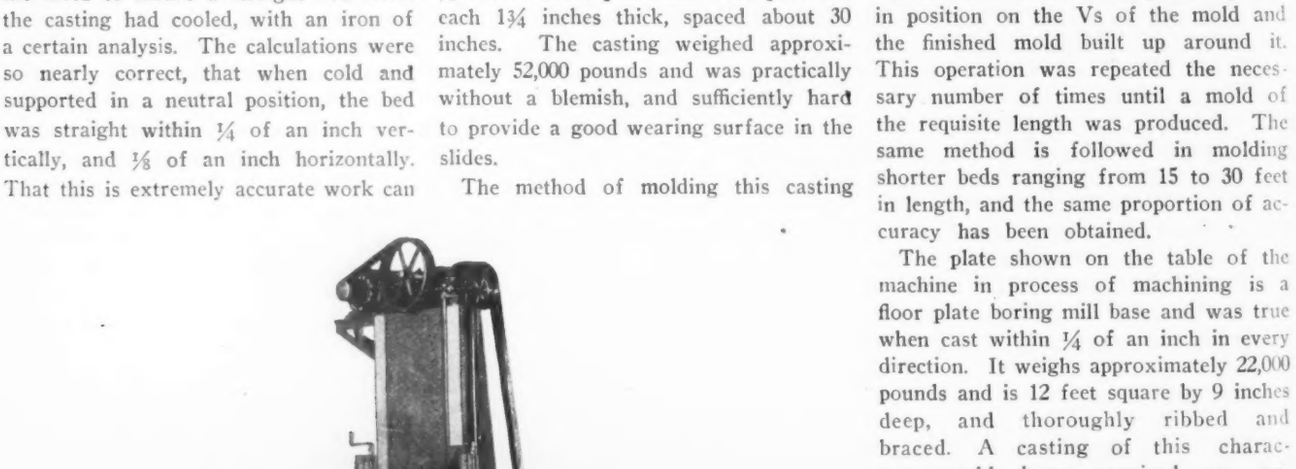
In the end, while the legitimate producer may suffer losses, the consumer is the heaviest loser through his possession of a tool that is only a counterfeit of the original. To succeed as builders of special equipment, concerns should be specialists not only in design but in production as well. The interlopers can only hope to succeed by initiating cut-throat competition, which will ultimately wipe out their profits as well as those of the legitimate manufacturers.

A LONG MACHINE TOOL CASTING

THE accompanying illustration shows a new open side planer recently built by the Cleveland Planer Works, Cleveland, which is noteworthy for the fact that it has a bed which is probably the longest machine tool casting ever made. The bed was cast in one piece, the object being not only to test the capacity of the foundry, but to demonstrate the amount of vertical curvature necessary in the mold to insure a straight bed when the casting had cooled, with an iron of a certain analysis. The calculations were so nearly correct, that when cold and supported in a neutral position, the bed was straight within ¼ of an inch vertically, and ⅛ of an inch horizontally. That this is extremely accurate work can be seen when the length of the bed is considered. The casting is 52 feet long, 45 inches wide and 27 inches high. It was cast closed on the upper side with the exception of an opening for the bull wheel, and closed on the lower side for that portion opposite the column base and a distance of about 6 feet in either direction with holes only large enough to permit the easy removal of the cores. The thickness of metal in the walls is ½ inch. Cross partitions were provided each 1¾ inches thick, spaced about 30 inches. The casting weighed approximately 52,000 pounds and was practically without a blemish, and sufficiently hard to provide a good wearing surface in the slides.

The method of molding this casting is of interest. A short section of pattern was used in comparison to the length of the finished casting, being about 12 feet in length. The mold was made top side down, and the Vs were first molded by means of a separate short pattern. One end of this pattern was pounded down into the sand the requisite distance to provide the calculated curvature in the mold necessary to produce a straight finished casting. The V pattern was then withdrawn and the main pattern placed in position on the Vs of the mold and the finished mold built up around it. This operation was repeated the necessary number of times until a mold of the requisite length was produced. The same method is followed in molding shorter beds ranging from 15 to 30 feet in length, and the same proportion of accuracy has been obtained.

The plate shown on the table of the machine in process of machining is a floor plate boring mill base and was true when cast within ¼ of an inch in every direction. It weighs approximately 22,000 pounds and is 12 feet square by 9 inches deep, and thoroughly ribbed and braced. A casting of this character would have required an extremely large planer to machine,



LARGE OPEN SIDE PLANER BUILT BY THE CLEVELAND PLANER WORKS

had not an open side planer been available. The planer illustrated is a 60-inch machine widened out to 72 inches. It allowed the work to overhang the platen on the column side about 8 inches. The table being 54 inches wide, the plate was balanced on the platen within about two tons.

The planer table is 31 feet long with Vs spaced at 36 inches center to center. The rack is 2½ pitch with 8-inch face. All gears and rack are of steel. The ratio of cutting to return speed is about 2¾ : 1 with belt speeds of 1,600 and 4,400 feet per minute respectively for 25 feet per minute table travel. The motor is of the induction type rated at 20 horsepower. The column is 60 inches wide and 30 inches deep at the lower side. It is fastened to the base with twenty 1½-inch bolts and doweled with four ¾-inch pins. The base to which the column is bolted is cast integral with the bed up to the level of the Vs.

The castings described above were made for the Cleveland Planer Works by the Johnson & Jennings Foundry Co., Cleveland, under the direction of Charles A. Olsen, superintendent.

A ROLL CLEANING DEVICE.

H. N. TUTTLE

We were formerly very much annoyed by the chips and shavings which became gummed on the lower rolls of the thickness planer by the resin from the lumber passed through it. This necessitated the cleaning of the rolls quite frequently, which not only took more or less time, but was often neglected, to the detriment of the work done on the machine. Finally, the expedient of putting a kerosene wiper upon them was tried and found more than satisfactory. In fact, though the rolls were in very bad condition when the device was applied, the machine had not been run more than one minute before the rolls were entirely cleaned.

The illustrations, Figs. 1 and 2, will show how the device was made and attached. Fig. 1 represents the end view of one wiper and roll, while Fig. 2 shows the front view of one-half the same, the other end being similar. The lettering is the same in either figure. A represents one of the lower rolls, B the bed under the knives, C the rib which drops down from the bed frame, outside the roll. The device consists of a bracket D, fastened to rib C by two cap screws, only one of which is shown at E. This bracket has a fork F at either end, which form the ways or guides for the oil cup G.

There are two ribs, not shown, cast on the outside of the oil cup to guide it endwise. This cup is filled to overflowing with waste, so that when it is pressed against the roll the cup itself does not rub against it. A recess H is cored or drilled in a lug on the bottom of the oil cup at either end and there is one in the bottom of the fork which make seats for a coiled wire spring. It will be noticed that the cup screw

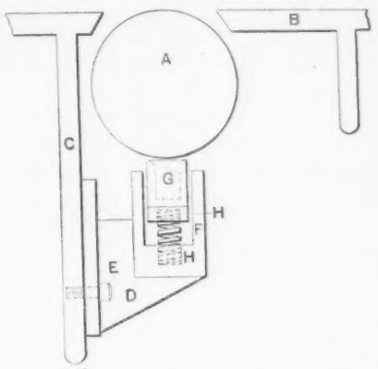


FIG. 1—END VIEW OF ROLL CLEANING DEVICE

passes through a slotted hole. This is done so that the bracket may be raised, thus putting a compression on the coiled springs, which in turn press the wiper lightly against the roll. It is needless to say that there is a wiper on either roll.

The only attention required is the occasional pouring of a little kerosene upon the top of the rolls. The oil flows around the rolls and into the waste cup, which will keep the rolls perfectly clean until the oil is evaporated. It is intend-

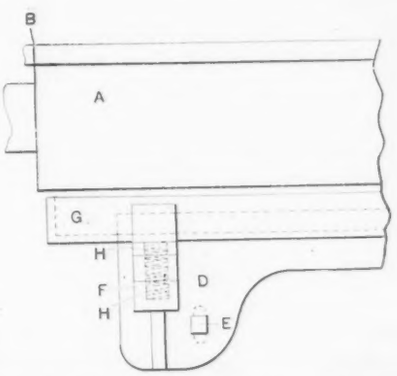


FIG. 2—FRONT VIEW OF ROLL CLEANING DEVICE

ed to oil the wiper about once a month, though, if it be forgotten until the rolls begin to gum up, the cleaning will be effected within a few revolutions after the application of the kerosene.

MICRO-CONSTITUENTS OF CAST IRON.

BY BRADLEY STOUGHTON

Question:—How many calories are given off in the oxidation of 1 pound of manganese oxide; of silicon to SiO_2? What constituents are shown in iron when examined by the microscope, containing carbon, 3 per cent; silicon, 0.67; manganese, 0.28; sulphur and phosphorus below 0.03 per cent? What would be the constituents of this iron when heated to 1,100 degrees Cent. and quenched in ice water?

Answer:—The heat of formation of one pound of

Manganous oxide, *MnO,=1,280 pound calories=580 kilogram calories.

Manganous oxide, Mn_3O_4=1,430 pound calories=650 kilogram calories.

Manganic oxide, MnO_2=1,440 pound calories=655 kilogram calories.

The heat of oxidation of one pound of manganese to

*MnO,=1,650 pound calories=745 kilogram calories.

Mn_3O_4=1,990 pound calories=900 kilogram calories.

MnO_2=2,280 pound calories=1,030 kilogram calories.

The heat of oxidation of one pound of silicon to SiO_2=6,430 pound calories =2,920 kilogram calories.

The kilogram calorie is the usual standard of measurement. One kilogram calorie=3.968 British thermal units; one pound calorie=1.8 British thermal units; One kilogram calorie=2.2046 pound calories.

In the cast iron cited there will be graphite, pearlite, ferrite, iron silicide, FeSi, and perhaps other compounds such as Fe_2Si, and manganese sulphide, MnS. The phosphorus will be in solid solution in the ferrite, and the manganese not united with the sulphur will be in the cementite of the pearlite as $(Fe.Mn)_3C$. This assumes that the cast iron was slowly cooled through the range of freezing. If it were rapidly cooled, there will be less graphite, perhaps none, and cementite, Fe_3C, instead of ferrite.

I think the last question must be a mistake. To heat this iron to 1,100 degrees Cent. would almost melt it, and no one would think of quenching it from such a high temperature. If he did, it would burn the iron and injure its properties. Moreover there would be no advantage in quenching from a temperature higher than 750 degrees Cent. (1382 degrees Fahr.) If it were heated to 750 degrees Cent., and quenched in ice water, its constituents would be: Graphite, martensite, iron silicides, manganese sulphide. If it had been rapidly cooled through the freezing range, there will be cementite in addition to the constituents mentioned.

*In steel we usually calculate upon MnO being formed.

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CONTENTS.

Silicon-Copper in the Brass Foundry 1
Molding a Difficult Casting..... 4
Difficulties Experienced Mixing Different Grades of Iron..... 5
The Advantages of Core Molding.. 7
The Cupola in Brass Foundry..... 10
Measuring the Capacity of Ladles.. 11
Large Cores Without Arbors..... 15
Alloy for Iron and Steel Castings.. 16
Tests of Vanadium in Cast Iron.... 17
Cylindrical Section Sweeping Device 20
Making Malleable Castings Without Annealing 22
Acid-Proof Metal 23
Production of Malleable Castings II 24
Car Wheel Chill 27
A. F. A. Convention at Toronto..... 27
Chicago Exhibit of Foundry Equipment and Supplies 28
Difficulties Resulting from the Expansion of a Heavy Core Arbor..... 29
Rat-tailing and Other Difficulties.... 30
Gray Iron Jobbing Foundry..... 31
New England Foundrymen's Association 33
Pitted Castings 34
High Sulphur Iron 34
Hard Iron from a Small Cupola..... 35
Chilled Castings 35
Ferro-Silicon for Malleable Heats.. 35
Flux for Sash Weight Iron..... 35
Use of Metal Cores in the Foundry.. 36
Philadelphia Conference on Short Weights 37
A Few Suggestions from a Practical Patternmaker 39
Commercial Piracy 39
A Long Machine Tool Casting..... 40
A Roll Cleaning Device 41
Proportions of Fans for Blowers... 42
Death of J. K. Bougher..... 43

Proportions of Fans for Blowers

The dimensions of the fan for the cupola blower are practically fixed by the manufacturer by the standardization of sizes. In so far as there is any reason for maintaining certain relations in the proportioning of a fan this is well and good. The manufacturer is supposed to know more about the matter than the user, and the supposition is well founded. There is something peculiarly elusive about the knowledge of blowers and their operation. At one moment the action seems perfectly logical, at the next it appears almost beyond explanation. But many factors enter to influence the operation of blowers. The fluidity of the air,—its properties of compression and expansion,—have much to do with increasing the difficulties, which are sufficiently complicated by the relations between pressure, density and velocity. It is, therefore, but natural that to most individuals a fan should appear to be a thing with which it would be unwise to tamper as regards changing its dimensions. Aside from this, it is certainly well that in the case of relatively small fans the size number or shell diameters should always serve as evidence or a measure of the capacity. The capacity in turn is always indicated by the proportions of the wheel. In ordinary practice the width of a pressure blower wheel at the circumference is from 5 to 8 per cent of the diameter. Two inlets are provided, each about one-half of the diameter. In other words, it is from two to three times the width at the circumference. In such a wheel the total area of the two inlets is approximately double the area for discharge around the entire circumference. But this area is greater than that of the outlet in the casing, and this, in turn, is far greater than the area over which the maximum pressure can be maintained. But because this outlet is large the ordinary individual is naturally led to connect a pipe at least its equal in diameter, and thereby to unwittingly avoid the losses through friction which would occur in a long pipe of lesser diameter. The province of the fan is really two-fold—to overcome resistance and to move air. The second function cannot be performed until the first is accomplished. In other words no air will be removed until the pressure is overcome. But a slight reduction in the resistance releases just so much of the otherwise wasted energy applied to overcoming it and renders it available for the production of velocity and the movement of air. Evidently the opposite occurs when the resistance is increased. The variations in conditions as regards resistance can be met by corresponding variation in speed of the fan, which in the case of increased resistance, for instance, may be speeded up just enough to overcome it and thereby render possible the movement of a constant volume of air. Or, were it possible to change the width of the fan as the occasion might demand, the volume within reasonable limits might be kept constant by increasing the width as the normal resistance was increased. That is to say, the wider wheel might have its delivery decreased through the effect of the resistance by an amount that would make the volume just equal to that discharged by the smaller wheel under normal resistance. Of course, an adjustable fan is out of the question, but it is possible when the conditions are known, to design a fan that will thus offset the effect of resistance without the necessity of excessive speed. In a word, if given conditions could be established and maintained it would be possible to design a fan of maximum efficiency to meet these conditions; but these are usually variable and are seldom well known in advance.

Trade Outlook

While there has been a slight improvement in foundry trade conditions during the last 30 days, the cost of raw materials has not declined in proportion to the selling price of castings. The pig iron manufacturers of the Central West have recently promulgated a new schedule based on $17 for No. 2 Foundry at the leading iron producing points. This quotation, plus local switching charges, represents the price asked at Buffalo, Pittsburg, Cleveland, Youngstown and other centers. Yet this price has been shaded and in the absence of heavy buying nearly represents nominal values. A perfunctory meeting of the merchant ore interests was also held early in February for the purpose of reaffirming last year's quotations. This was done without difficulty as none of the furnace operators are in the market and will probably not interest themselves in their future supply until the summer months. Steel products are likewise being held on a nominal basis. Prices of all kinds of castings have, however, declined, although the metal in most instances with which orders are now being filled was purchased at prices ranging from $8 to $10 a ton above present prices. Dealers and manufacturers in foundry supplies report a heavier demand for their products, but the amount of new equipment that is being purchased is limited owing to the stoppage of extensions and new building operations. The coke production of the Connellsville

region during 1907 amounted to 19,029,058 tons as compared with 19,999,326 tons the previous year. The average price at the ovens was the highest recorded since 1903, both foundry and furnace grades having averaged $2.90. The low point was reached in 1894 when $1.00 a ton was the average. Quotations of non-ferrous metals remain practically unchanged and the brass foundries report only a slight reaction from the recent depression.

PRIZE CONTEST AWARDS.

The five articles awarded prizes in the contest conducted by THE FOUNDRY are published in this number. The other articles submitted and accepted will appear in later issues.

Awards were made as follows:

First Prize—C. Vickers and A. C. Hemist equally share the first award of $50 for their articles on "Silicon-Copper in the Brass Foundry" and "Measuring the Capacity of Ladles," respectively.

Second Prize—"The Use of Metal Cores," by George Buchanan.

Third Prize—"Cylindrical Section Sweeping Device," by Jabez Nall.

Fourth Prize—"Large Cores Without Arbors," by Paul R. Ramp.

DEATH OF J. K. BOUGHER.

J. K. Bougher, president of the J. W. Paxson Co., Philadelphia, manufacturers of and dealers in foundry supplies and equipment, died at Palm Beach, Florida, Wednesday, Feb. 12, aged 68 years. His passing away removes one who might be appropriately called the dean of the foundry supply business of America and who was the last remaining member of a coterie of men who were active during the 70's, 80's and 90's, in the development of a business that has since grown to be a great industry.

His contemporaries in this work were Simon Obermayer, the founder of the S. Obermayer Co., Cincinnati, who passed away in 1898; J. D. Smith of the J. D. Smith Foundry Supply Co., Cleveland; J. W. Paxson, who with Mr. Bougher founded the house of J. W. Paxson Co., and A. J. Miller, Providence, R. I., of the old established concern, known for nearly half a century as the Whitehead Bros. Co.

In a personal way he was of an exceedingly lovable, sociable disposition, and while constant in his devotion to business, giving to it during all of the best years of his life all of his energy, yet no occasion arose requiring his aid in a personal and social way that he did not cheer with his kindly advice and support. He had hundreds and thousands of friends scattered through every state in the Union who will be deeply grieved to learn of his demise.

J. K. BOUGHER

To his family, partners and business associates, THE FOUNDRY extends its sincere sympathy, and it is but a poor consolation to remind them that this incomparable loss is not theirs alone, but it is one that they must always share with all who knew him well—because to know him well was to admire him and be his friend.

While still a young man Mr. Bougher made the acquaintance of J. W. Paxson, and together they organized the J. W. Paxson Co., miners and shippers of foundry sand. They later built facing mills, machine, boiler and blacksmith shops, as well as a plant for manufacturing all kinds of wire and bristle brushes, sieves, riddles, etc., for foundry use. For carrying their products inland as well as along the Atlantic coast, barges and steamers were later added to the equipment. Before the organization of the J. W. Paxson Co., Mr. Bougher was captain of a tug-boat on the Delaware river and its tributaries and he also served in the Union army throughout the civil war.

He was also connected with many other enterprises, and was a director of the Kensington National Bank and president of the following concerns at the time of his death: Lumberton Sand Co., Philadelphia; Burlington Sand Co., Hainesport, N. J., and the Welsh Mountain Mining & Kaolin Co., Philadelphia.

He built and equipped, from his own private fortune, the electric road operating between Burlington and Mt. Holly, N. J., a distance of six miles, and from the latter point to Moorestown, N. J., a distance of seven miles, connecting with the Public Service Corporation running into Camden, N. J.

Mr. Bougher was a prominent Mason and Knight Templar and was a member of the Union League, Manufacturers' and Columbia clubs of Philadelphia. Funeral services were held at his late residence, 1823 Broad street, Philadelphia, Monday, Feb. 17, and the interment was at Riegelsville, Pa.

FRANK W. GOULD.

The life of Frank W. Gould, president of the Union Malleable Iron Co. of East Moline, Ill., was brought to a close Saturday morning, Feb. 8, at his residence in the city of Moline. Not more than ten minutes before he died, he had been engaged in making business engagements which were to take him down town a half hour after the time of his death. He had not been himself for several days, and his illness necessitated that he remain about the house. The cause of Mr. Gould's collapse is assigned to the pressure of financial demands, which had been considerably heightened by the recent financial depression through-

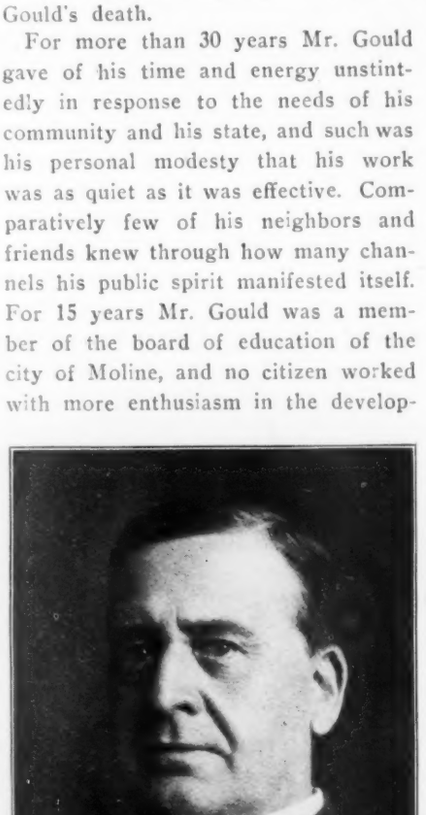
out the country. His embarrassment, however, had nothing whatever to do with any business concern in which he was interested, as none was at all involved in his personal affairs. At his home city, no one could have been held in higher personal regard by the public or enjoyed its confidence to a greater extent. He had grown into the trust and esteem of those among whom he moved to a degree akin to personal affection, and he was generally respected for his high standard of integrity and his plain, unassuming, genial ways.

Mr. Gould was born in Moline, March 25, 1853, the son of Judge and Mrs. J. M. Gould. After his years in the Moline schools, he went to Yale, from which he was graduated in 1876. Mr. Gould became associated with Dimock, Gould & Co., the lumber industry of his father, on his return from college, and was secretary of the concern till 1899, when the sawmill was discontinued. He then became president of the Union Malleable Iron Co., which position he held till his death.

Mr. Gould was appointed a trustee of the Western Hospital for the Insane at Watertown by Governor Tanner in February, 1897, and was reappointed by Governors Yates and Dineen. Immediately on his original appointment he was elected president of the board, continuing in the position until his death. Mr. Gould was a stockholder in the People's Savings Bank & Trust Co., and in the Manufacturers Hotel Association, and had served as president of the Moline club. Surviving him are his father, his widow and daughter, Mrs. Joshua Hale, of Newburyport, Mass.

The great number of friends which gathered at the family residence at the funeral of Mr. Gould was a striking tribute to his personal worth and the esteem in which he was held throughout every circle into which business or pleasure had called him. The beautiful home, Eastmont, was filled before the hour set for the funeral. Conspicuous among the flowers was a set piece which was sent by the employes of the Union Malleable Co. The shops were closed down the day of Mr. Gould's death and were idle until after the funeral. Wreaths from men and organizations with which Mr. Gould had been connected were numerous. But what impressed one most was the quantity of the flowers, as a whole, representing, as they did, a large number of people whose hearts had been touched by Mr. Gould's death.

For more than 30 years Mr. Gould gave of his time and energy unstintedly in response to the needs of his community and his state, and such was his personal modesty that his work was as quiet as it was effective. Comparatively few of his neighbors and friends knew through how many channels his public spirit manifested itself. For 15 years Mr. Gould was a member of the board of education of the city of Moline, and no citizen worked with more enthusiasm in the development of the schools. His administration of the affairs of the board of trustees of the Western Hospital for the Insane during the ten years of his presidency illustrate the same high qualities. He was also paymaster in the Illinois Naval Reserves when organized, and for several years thereafter. His interest in this organization was natural, for he had been captain in the state militia for several years, and he manifested that interest in a characteristic way—by the employment of his fine business abilities, without pay. He was elected alderman in the old days from what was then known as "the bloody third" by a majority of five votes. It had been said that no man not a saloonkeeper could be returned from that ward.



FRANK W. GOULD

"No life lived in Moline during the present generation has in the recital of its activities more of inspiration to the higher citizenship than Mr. Gould's," said a personal friend. "The long years will not be forgotten by his fellow citizens, and nothing can blot out such a record of magnanimous, self-forgetful, unassuming, effective service—service rendered without money and without price—in the midst of years heavy with the cares of a successful business man and manufacturer, who inquired but one thing: whether, in the appeals that came to his ears, anything was demanded that his strength and devotion could supply."

The Malleable Iron Manufacturers' Association, at a meeting in Chicago shortly after the death of Mr. Gould, adopted resolutions deploring his death and extending sympathy to his family, in which appeared this personal tribute: "Mr. Gould's fine character, his cheerful disposition and his general lovableness made him a delightful companion, while his integrity of purpose, his broad-mindedness and his spirit of brotherliness attached him peculiarly to every member of our association. We feel that his loss is a personal one."

ARTHUR B. STEVENSON.

Arthur B. Stevenson, Chicago manager for DeCamp Bros. & Yule Iron, Coal & Coke Co., St. Louis, died at his home in Chicago, Jan. 30, from an attack of typhoid fever. Although only 32 years of age, he was widely known in the pig iron and coke trade and leaves many friends among both associates and competitors. For 10 years he was associated with the St. Louis firm of the C. A. Stevenson Pig Iron & Coke Co., seven years in the St. Louis territory and three years as manager of its Chicago office. Four years ago he accepted the management of the office just opened in Chicago by DeCamp Bros. & Yule, and through his ability and energy developed the venture into a marked success.

PERSONAL.

Celestin Couanon, representing the Paris firm of Fenwick Freres & Co., is in this country for a four months' visit to the plants manufacturing those lines of foundry equipment for which his company acts as European selling agent. For the next few weeks he may be addressed in care of the Tabor Mfg. Co., Philadelphia.

Edward F. McLaughlin, secretary of the Enterprise Foundry Co., Muskegon Heights, Mich., has resigned and re-

turned to Houghton, Mich., where he will engage in the steel business.

James T. Hayden has retired from the position of superintendent of the brass department of the Crane Co., Chicago, after 22 years of service, but will remain with the company in a different capacity. Mr. Hayden was in charge of a brass foundry for 14 years before taking his position with the Crane Co.

At the annual meeting of the Buckeye Steel Castings Co., Columbus, O., Frank Rockefeller, of Cleveland, retired from the presidency and was elected second vice president. S. P. Bush, formerly second vice president and general manager, succeeds Mr. Rockefeller and will continue as general manager.

H. S. Ridenour, formerly superintendent of the plant of the Pittsburg Industrial Iron Co., Huntingdon, W. Va., has accepted a position of foreman of the foundry of the Canton Hughes Pump Co., Canton, O.

Charles A. Bacmeister, who has had an extensive experience in the sale of grinding wheels, has been appointed western representative of the Monarch Emery & Corundum Wheel Co., of Camden, N. J. His headquarters will be in Chicago.

A. W. Mayer, a traveling representative of the W. W. Sly Mfg. Co., Cleveland, sailed recently for England, where he will assume charge of the company's constantly growing business in the British isles. The W. W. Sly Mfg. Co. has developed a big demand for its tumbling mills and other foundry equipment, not only in the British isles, but on the continent as well.

Philip J. Nash has been placed in charge of the Chicago sales department of the Ernst Wiener Co., New York. Mr. Nash has had a varied experience in industrial railway work. The Chicago offices are located at 863 Monadnock building.

John O'Donnell has resigned as superintendent of the foundry of the McConnell Engineering Co., Tacoma, Wash. He was formerly general foreman of the gray iron and malleable foundries of the McCormick branch of the International Harvester Co., Chicago.

MALLEABLE MIXTURES.

By Richard Moldenke

Question:—What should be the analysis of pig iron to produce good malleable castings, and what percentage of gates and sprues should be used? I would also like to know why the cupola cannot produce as good malleables as the air furnace?

Answer:—To answer in detail would require considerable space, and information covering the questions asked will be given by the writer in the series of articles on malleable practice that are now being published in The Foundry. In a general way this can be said: Select a good, "honest" iron, that is made for malleable casting purposes specially. The analysis should be as follows: Silicon between 0.75 and 2 per cent, depending upon the weight of the castings. The 2 per cent, with some lower silicon irons, for the very lightest, and some of the 0.75 with enough higher silicon pig and sprues to make the mixture about 0.85 per cent silicon for the heavy classes of malleable work, the sulphur as low as you can get it, not over 0.04 per cent; phosphorus not over 0.225 per cent, and manganese not over 0.75 per cent, preferably not over 0.40 per cent if it can be had conveniently..

Make your mixture to use up your daily sprues. The ordinary amount is 50 per cent. Manufacturers of light work have to use more to get rid of their production of sprues and bad castings in the hard. Makers of heavy work get about 40 per cent, and use only that much. Malleable scrap is difficult to use, but if understood is excellent. You can use up to 80 per cent in the mixture, but you will have bad looking castings, but the strongest you ever made. Better take no more than 20 per cent, which should give you no trouble. You must have very hot runs, however, to succeed.

In the cupola the iron is in contact with the fuel and is damaged by contact with sulphur as well as a higher oxidation than is the case in the furnace, therefore, poorer material results. Not only is this the case, but a higher annealing heat is required. For important work cupola iron should not be used. For pipe fittings, and hardware castings it is satisfactory, and much used, being cheaper.

SOCIETY FOR PREVENTION OF ACCIDENTS.

Thomas D. West, Sharpsville, Pa., has undertaken the organization of a society for the prevention of accidents. It is the hope of the originator that the society will grow to be a strong factor in decreasing fatalities and injuries by accident. At the recent meeting of the Philadelphia Foundrymen's Association, Mr. West discussed fully the "Dire Cost of, and Best Remedy for, Carelessness in the Foundry, Shop, Transportation and Traveling."

SHRINKAGE OF YELLOW CASTINGS.

By C. Vickers

Question:—I occasionally experience some trouble with yellow brass castings which develop black spots on the surface after the castings have been dipped. The copper we charge consists of scrap wire. For our yellow brass the cleanest trolley wire is selected. We use No. 18 and No. 20 crucibles and to every pot we add two small handfuls of salt during the heat. One handful is added when the crucible is put into the furnace and the other after the copper is melted down, and at all times tan bark is kept on top of the metal. It is used in place of charcoal because it is cheaper and the same results are achieved. When charcoal is used the same difficulties mentioned above are experienced. The mixture used is as follows: One pound of copper, eight ounces of zinc and ½ ounce of lead. We are always exceedingly careful not to let the metal get too hot, that is, to smoke, and about 20 minutes before pouring we add the mixture of zinc and lead and let the whole come to the required heat and then we pull the pot. We are particular to have the metal well stirred before pouring.

Answer:—I think these spots are caused by shrinkage. The mold should be gated on the other end if possible, or the runner should be built up to give the casting a chance to draw metal therefrom to overcome the shrinkage.

ASSOCIATED FOUNDRYMEN OF PHILADELPHIA.

At the regular meeting of the Associated Foundrymen of Philadelphia and vicinity, held at Dental Hall, Philadelphia, Feb. 10, Sidney A. Loog read a very interesting paper on "The Importance of Foundry Cost Keeping." At the March meeting a paper will be read on "Molding Sands," by Joseph Toy.

WROUGHT IRON IN THE MIXTURE.

By T. Shaw

It is surprising as one visits different foundries, to find how adverse most foundrymen are to using wrought iron, or steel, in their regular charges, but depend upon their favorite brands of iron to overcome all anticipated troubles. When we consider what wrought iron really is we will be more partial to it. It is a product that contains a high percentage of metallic iron, and as such can be depended upon more than steel to lower the impurities of the iron and close the grain. Steel and iron are variable in their contents of the elements and are not to be ranked with wrought iron to overcome a good many of our machine shop troubles, and it would be well if all foundries would have it occasionally on hand as scrap.

FOUNDRY & PATTERN SHOP EQUIPMENT

Automatic Core Machine—Factory Pans and Tote Boxes—Portable Heaters—Adjustable Flask Bar

A MACHINE for the manufacture of both straight and intricate cores has been designed and is being built by the Diamond Clamp & Flask Co., Richmond, Ind. The operating principle is similar to that of stamping articles out of sheet metal. Metal core boxes are used exclusively, parting the same as the ordinary core box, and they can be used either singly or in multiples, generally called gang boxes.

The sand is contained in a hopper and is fed into a vertical sand sheet tube by the swiper and is forced through the tube by a plunger. When the sand sheet shown in Fig. 1 has reached the proper height the plunger and swiper stop, the two halves of the core box come together and form the core as shown in Fig. 2. The surplus sand drops into the hopper and while the two halves of the core box are together the core is rapped and automatically vented by the needle shown in both Figs. 1 and 2.

When the two halves of the core box release the core and assume the position shown in Fig. 2, an arm, not shown in the illustration, swings under the core and carries it away from the machine, while the operation of making the core is being repeated.

Plain cores in multiple boxes can be made as fast as the operator can carry them away. The machine is provided with a variable speed for difficult cores that must be wired or nailed. By the change of speed the operator can be given sufficient time to wire or nail the cores, and by means of the foot treadle the machine can be stopped in any position. Aside from the changing of the core box, which requires about three minutes, there is only one other change which is made in its readjustment and that is, from a flat sand sheet to a round one. The flat sand sheet is 1⅛ inches thick and 2¾ inches wide and by means of a thumb screw can be reduced to ¼ inch thick and 2¾ inches wide or any other size between these two dimensions. The round sand sheet is 2½ inches in diameter and can be reduced to 1 inch without changing the plunger. All of the operating machinery is enclosed and cannot come in contact with the sand.

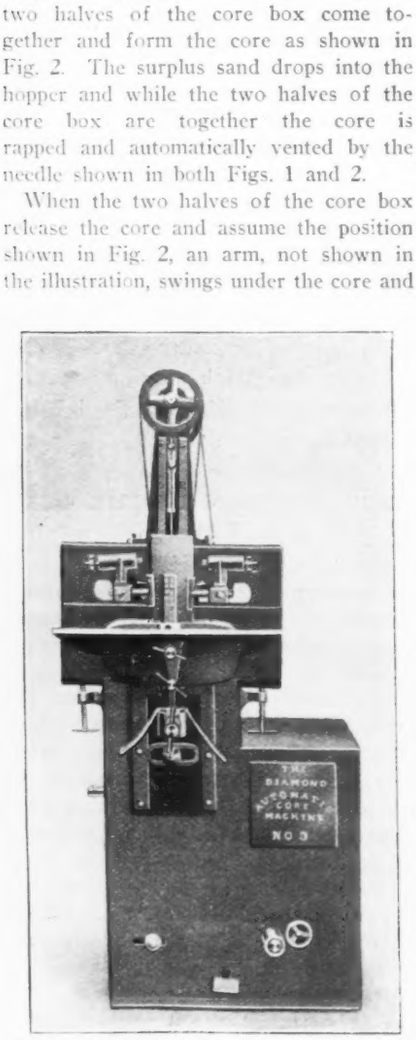


FIG. 1—AUTOMATIC CORE MACHINE SHOWING SAND SHEET

DEVICE FOR SHAPING CRUCIBLE TONGS.

The February issue of *Graphite*, published by the Jos. Dixon Crucible Co., Jersey City, N. J., contains a description of an iron crucible intended for use as an anvil on which crucible tongs can be shaped. From the bilge, or its widest section downward, the iron crucible has the same shape as the graphite crucible, but from the bilge upward it is made a trifle larger than the crucible, so that when the tongs are perfectly fitted on the pot there will be sufficient space to prevent any possibility of squeezing when placed on a graphite crucible. These pots are made to match the various sizes of crucibles. The brass foundryman can thus be his own blacksmith and by heating the tongs in the furnace and clamping them on the iron pot as they would be clamped on a graphite crucible they can be forged into shape in a very short time. It is almost impossible for the ordinary blacksmith to shape a pair of tongs on an anvil so that they will fit the crucible perfectly.

Inasmuch as there is considerable outlay involved in making patterns for iron crucibles and as the brass foundry requires only one of each, the Jos. Dixon Crucible Co. has arranged with E. R. Klemm, 103 West Monroe street, Chicago, to furnish these iron crucibles for all of the standard sizes of Dixon's crucibles.

PANS AND TOTE BOXES FOR FACTORIES.

The accompanying illustrations show some pressed steel pans and tote boxes made by the Kilbourne and Jacobs Mfg. Co., Columbus, O., for use in machine shops, foundries, bolt works, etc. The pan, shown in Fig. 1, is adapted to handling castings, bolts, rivets, nails and parts of machines for all purposes for which tote boxes are used. It is pressed from a single sheet of heavy steel and is without a seam in its construction. The inside is, therefore, perfectly smooth. It is given great rigidity and strength by a flange along its top or a steel rod beaded around its edge, if preferred. It will not buckle or crush when loaded to its capacity with heaviest material. These pans are furnished with rolled

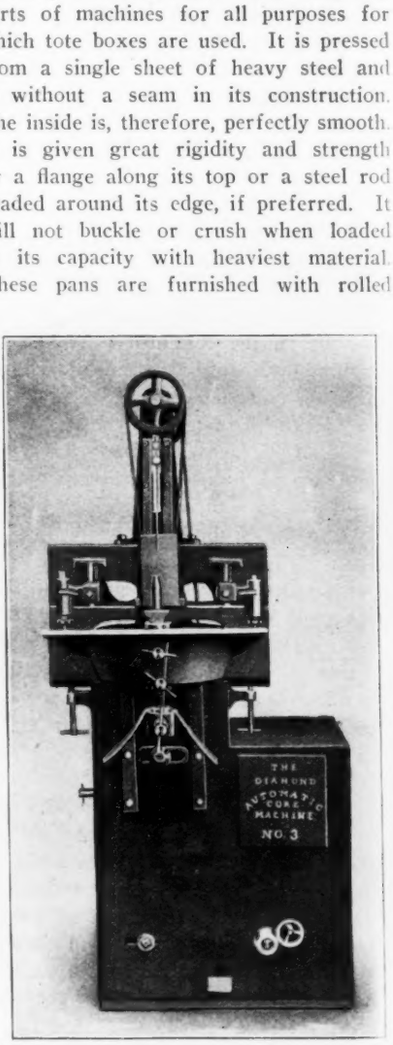


FIG. 2—AUTOMATIC CORE MACHINE SHOWING FINISHED CORE

steel handles, as shown. They require but little storage space, since their tapering form admits of their being nested.

In cases where a few boxes of special size, to fit racks or shelves, are desired, and where, on this account the cost of a special die for the stamping of pressed steel boxes would be prohibitory, the company furnishes riveted steel tote boxes of the type shown in Fig. 2. These boxes are furnished in any gage steel. The corners are flanged and firmly riveted and the top edge is folded, giving the box great rigidity and strength. These boxes may be also furnished in any size. They have a flat bottom and are very well adapted to stacking. They are widely used in foundries.

Another new, useful and convenient article of foundry and machine shop equipment is the steel barrel and truck shown in Fig. 3. These barrels have a corrugated steel bottom. The bottoms are stamped from a single sheet of steel, which process corrugates the steel and forms a flange 1 inch deep. This process gives great strength where it is most needed and where the ordinary barrel is weak. These barrels may be also furnished with the stamped bottom having the flange, but without the corrugation. The shell is made from one piece of steel and has only one side seam which is securely riveted. The barrels are bound at the top with a heavy band. When furnished with the truck the barrel is equipped with malleable iron trunnions which are riveted to the barrel a little above the center. This perfect balance permits a barrel which contains as much as 1,000 pounds to be easily dumped while on the truck. The truck handles, braces and axles are made of steel. The wheels are 13⅝ inches diameter.

FIG. 1—PRESSED STEEL PAN

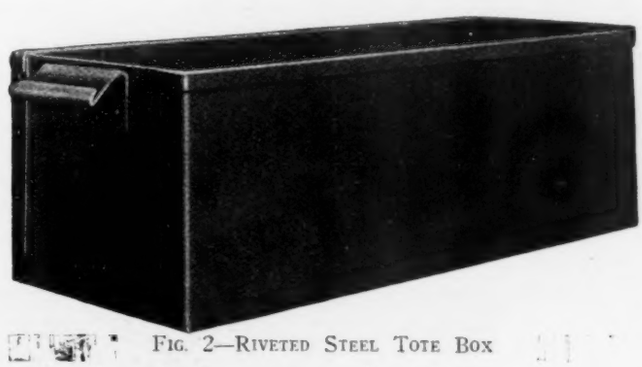


FIG. 2—RIVETED STEEL TOTE BOX

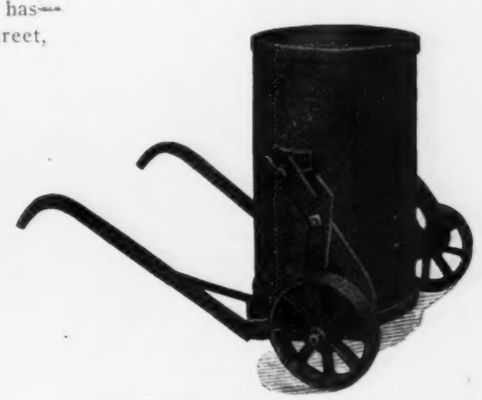


FIG. 3—STEEL BARREL AND TRUCK

TRADE NOTES.

The general offices of the Quincy-Manchester-Sargent Co., located at 90 Wall street, New York, on Feb. 1 were removed to the factory at Plainfield, N. J. C. H. Holbrook continues as manager, but is now located at Plainfield, and the machinery and engineering work of the New York office is now looked after by Charles Gilman.

The Ohio Blower Co., Cleveland, manufacturer of exhaust heads, ventilators, blowers, etc., has increased its capital stock from $25,000 to $50,000. A new plant is contemplated, but plans for its erection have not yet been perfected.

The Debevoise-Anderson Co., 95 Liberty street, New York, has secured the exclusive eastern agency for the products of the Midvale Mining & Mfg. Co., St. Louis. These include prepared ferro-manganese, ferro-silicon, silico-manganese, and a special preparation known as carbonese. The Midvale Co. has been supplying these products to the foundry trade for more than a decade.

The American Wire Brush Co. has removed its office from 25 Broad street, New York City, to larger quarters at 277 Greenwich street. In addition to its line of Minerva brushes for the metal, stone trades, etc., this concern has recently branched out into the manufacture of mechanically operated brushes for the cleaning of large surfaces.

The Roessler & Hasslacher Chemical Co., New York, manufacturer of ferro-alloys and metals, including chromium, ferro-silicon, tungsten, manganese, etc., has sent to the trade a handsome calendar containing an illustration of the "Walk to the Iron Foundry." The story of the illustration is contained in an eight-page booklet which has been issued separately.

Owing to the rapid growth of its business, the Central Foundry Supply Co., Columbus, has been compelled to move into larger quarters which provide improved facilities for conducting its affairs. Although organized only a year this concern has furnished the complete equipment for several large foundries recently built in the central west, and a heavy continued demand is reported for its products.

The United States Graphite Co., Saginaw, Mich., miners and manufacturers of graphite, are sending to the trade an interesting booklet entitled, "About Graphite Lubrication."

Regarding the use of magnesium, the C. W. Leavitt & Co., St. Paul building, New York, in a circular just issued, state that this metal should be added to the mixture as it passes from the pasty to the liquid condition. The crucible should remain in the oven at the time of adding the magnesium, and also after this has been done. The melting temperature is then increased and the mixture is subsequently worked up until well finished. When the deoxidation has been completed the skimmed metal will show a white-red surface of clear appearance.

At the annual meeting of the G. Drouve Co., Bridgeport, Conn., G. Drouve was elected president and treasurer, and Wm. V. Dee was elected secretary and general manager of sales.

This concern manufactures the Anti-Pluvius skylight, of which 25,000 square feet have been installed in the Hoboken terminal of the Lackawanna railroad.

The Rathbone Molding Machine Co., Detroit, has been incorporated with an authorized capital of $100,000. The new corporation has taken over the molding machine business previously conducted by John A. Rathbone, and will continue the manufacture and sale of the Rathbone multiple molding machine.

The Smooth-On Mfg. Co., Jersey City, N. J., manufacturer of iron cements, has recently opened the following offices: Chicago, 61-69 N. Jefferson street; San Francisco, 20 Sacramento street, and 8 White street, Moorfields, London, E. C., England.

The Killing Molding Machine Co., Davenport, Ia., manufacturer of molding machines, flasks and other foundry equipment, owing to its steady increase in business has been compelled to seek larger quarters, and has purchased the plant formerly occupied by the Simplex Washing Machine Co. of Davenport. The company's machine shop and foundry equipment will immediately be installed in the new quarters.

President J. Frank Dye, of the Newport Sand Bank Co., Newport, Ky., states that the company's mail on Feb. 10 contained more orders than all of the other correspondence received in the previous six weeks. This would indicate a revival in the demand for castings, as the sand business is an excellent barometer of the foundry trade.

The Macphail Flask & Machine Co., Chicago, announces that it has cancelled its manufacturing and selling arrangement with Baldwin, Tuthill & Bolton, Grand Rapids, Mich. Henceforth, the Macphail patented flask will be manufactured in the company's plant at Chicago. The main offices are located at 334 Dearborn street.

The Sioux City Foundry & Mfg. Co., Sioux City, Ia., has installed a 5-ton Newten cupola furnished by the Northern Engineering Works, Detroit.

Gulick-Henderson & Co., Pittsburg, chemists and metallurgists, inspecting engineers and adjusters of foundry troubles, have issued a booklet containing a price list, giving the cost of their professional services for making analyses, assaying, etc.

E. E. Brown & Co., Philadelphia, manufacturers of sash and elevator weights, are sending to the trade an interesting and original booklet entitled, "The Moneron, the Monkey, the Man, Their Affinities."

FIG. 1—ROCKWELL PORTABLE HEATER

ROCKWELL PORTABLE HEATERS.

For heating work which is too bulky or inconvenient to remove to a furnace, and where it is convenient to take the heater to the work, such as in annealing, hardening, expanding, bending, brazing, skin-drying molds, etc., the Rockwell Engineering Co., New York, is manufacturing two styles of portable heaters. One is self-contained, in which the oil is vaporized and burns kerosene only. The oil consumption is two gallons per hour, and, as shown in Fig. 1, the hand pump on the tank is used for charging the tank with oil as well as for obtaining an air pressure of 25 pounds. As the air expands only in proportion to the amount of oil consumed, it requires little attention. The compressed air type burns crude or refined oil only. The heater is adapted for skin-drying molds as shown in Fig. 2. While an air pressure of 50 pounds or higher gives the best results for high temperatures, such as is required in brazing. A pressure of 10 to 20 pounds is ample for skin-drying molds, where a soft sweeping flame is desirable. The heater is not only adapted for skin-drying molds and cores, but for heating and drying ladles, firing coke in small cupolas, melting soft metals, heating castings preparatory to burning in patches, etc.

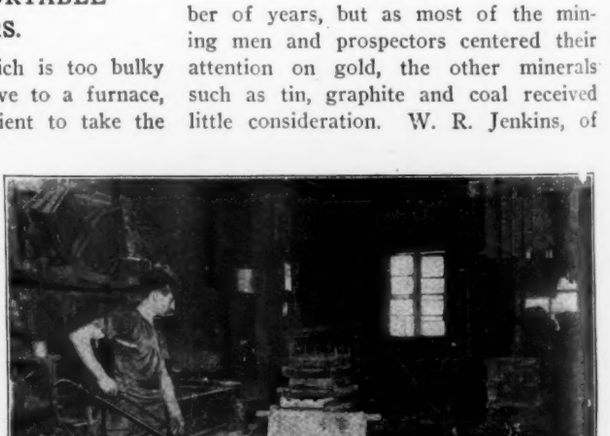


FIG. 2—PORTABLE HEATER SKIN DRYING MOLDS

MONEL METAL.

Isaac G. Johnson & Co., Spuyten Duyvil, New York, is now producing small and complicated castings from an alloy known as Monel metal. It is said to be non-corrosive, and contains from 70 to 80 per cent of nickel. This metal is made in different grades. What is known as grade B has a tensile strength of 85,000 pounds per square inch; elastic limit 40,000 pounds per square inch; 10 per cent elongation in 2 inches, with a reduction of area of 14 per cent. Grade C has a tensile strength of 65,000 pounds per square inch; elastic limit 25,000 per square inch; 30 per cent elongation in 2 inches and 35 per cent reduction of area.

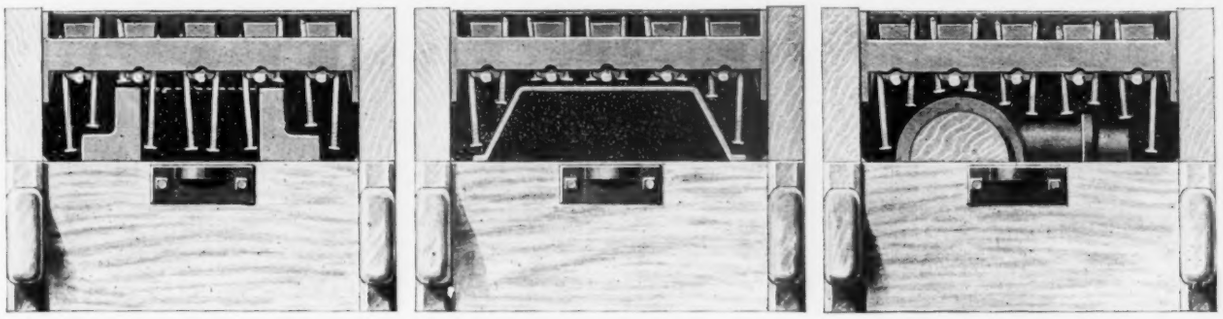
DEPOSITS OF GRAPHITE IN ALASKA.

The extensive deposits of graphite in Alaska have been known of for a number of years, but as most of the mining men and prospectors centered their attention on gold, the other minerals such as tin, graphite and coal received little consideration. W. R. Jenkins, of

San Francisco, appreciating the value of the graphite deposits in the Port Clarence district of Alaska, about 100 miles from Nome, organized the Alaska Graphite Co., for the purpose of developing this property and the shipment of its product to San Francisco. This concern has a piece of graphite on exhibition at its offices at Oakland, Cal., weighing 178 pounds, which contains about 75 per cent of pure carbon. B. G. Elliott, manufacturer of foundry facings, is now preparing this product for the foundry trade.

ADJUSTABLE FLASK BAR.

To properly support or anchor sand in molds, the Mitchell-Parks Mfg. Co., St. Louis, has recently designed and received patents on an adjustable flask bar shown in the accompanying illustration. Wooden bars with nails driven into their edges are now generally used in foundries, but as the nails soon burn loose and fall out, constant expense is incurred in keeping them in repair. The adjustable bar overcomes practically all of the disadvantages of the old style bar and can be adjusted to the peculiar forms of different patterns as shown in Figs. 1, 2 and 3.



FIGS. 1, 2 AND 3—APPLICATION OF ADJUSTABLE FLASK BAR TO VARIOUS PATTERNS

The bars are cast in one piece in lengths to fit the various flasks in use. The slots through the center of the bars for anchors and wedges are cored out, thus obviating all machine work. Either wire nails, or wire cut the proper length with one end bent at right angle to form the head, can be used as anchors. To move or adjust the anchors, the keys are loosened by striking the small end with a hammer and the large end is given a light blow to secure the pair of anchors in position.

Each of the anchors can be independently adjusted vertically or to any angle necessary to support the sand in weak spots. While these bars can be used to advantage with the roughest temporary wooden flasks it will be found more economical to replace the temporary flasks with those made of cast iron, since a comparatively small number of assorted sizes when equipped with adjustable bars will answer all requirements.

The Mitchell-Parks Mfg. Co. will either sell shop right for the use of the bar, or will furnish the bars to those securing license, in any length desired.

TRADE PUBLICATIONS.

PNEUMATIC TOOLS.—The Cleveland Pneumatic Tool Co., Cleveland. Catalog G. Thirty-two pages 6 x 9 inches. The tools illustrated and described include inside latch riveting hammers, outside latch riveting hammers, with instructions as to use, chipping, caulking and beading hammers, with tables of capacities and other useful information, stone and scaling hammers, reversible and non-reversible drills, with tables of cavacities of each type, short angle gears, long angle gears, lightning hose clamp tools, oscillating valve grinders, rotary breast drills, the Gunnel pneumatic rivet forge, etc.

FLASKS.—The Brass Founders Supply Co., Newark, N. J., has issued a neat 12-page booklet devoted to a description of its interchangeable flasks. Ribbed flasks are shown, as well as the improved ribbed flasks provided with a lifting bar. A number of testimonials from satisfied users are also reproduced. On several pages are given the dimensions, as well as the prices, of the many different sizes of brass molders' ribbed flasks manufactured by this concern.

PYROMETERS.—The Schaeffer & Budenberg Mfg. Co., New York and Chicago, has issued a catalog, 160 pages, which not only describes the complete line of thermometers, pyrometers and hydrometers manufactured by this concern, but gives much valuable information regarding their use. Mercury and electrical pyrometers are shown and described; the latter being designed for measuring temperatures up to 2,900 degrees Fahr. The electrical pyrometer adapted for foundry use, and for measuring the temperature of molten metal is also shown. The lower portion of the element, which is inserted into the metal, is protected by crucible material or by a tube of pure graphite with an insertion of quartz glass. The melting and boiling points of various metals and products are among the data included in this catalog, together with a table of heating degrees.

IRON CEMENTS.—The Smooth-On Mfg. Co., Jersey City, N. J., has published an eight-page folder which gives the history of Smooth-On products.

LIFTING MAGNETS.—The Cutler-Hammer Clutch Co., Milwaukee, Wis., has issued a neat 30-page booklet, which reproduces an article on lifting magnets and recent improvements in this device originally published in *Cassier's Magazine* in Oct., 1907.

FOUNDRY BRUSHES.—An eight-page folder showing a complete line of wire brushes has been issued by the American Wire Brush Co., New York. In addition to the complete line for foundry, machine shop and power plant use, this concern manufactures flexible wire brushes for breweries, refineries, agricultural purposes, etc.

PORTABLE HEATERS.—The Rockwell Engineering Co., New York, has issued a four-page folder, which describes portable heaters for heating work which is too bulky or inconvenient to remove to a furnace, and where it is convenient to take the heater to the work, such as annealing, hardening, expanding, bending, brazing, skin-drying molds, etc. The heaters are made in two styles. One is self-contained, in which the oil is vaporized and burns kerosene only; the other is operated in conjunction with compressed air, which is necessary for atomizing the crude or fuel oil, which may be burned as well as kerosene.

BLOWERS.—Bulletin 152, issued by the B. F. Sturtevant Co., Hyde Park, Mass., is devoted to a description of the single impeller blowers made by this concern. Numerous sectional views of the blower are shown, which illustrate the four successive stages in the movement of the rotors and clearly indicate the principle upon which the blower operates. The daily cupola record issued by this concern for the month of February has likewise been received.

GRINDING AND POLISHING MACHINERY.—A 12-page leaflet has been issued by the Webster & Perks Tool Co., Springfield, O., showing its line of grinding and polishing machinery. The booklet contains illustrations of bench, pedestal and oil grinders, and buffing and polishing lathes.

WATER LEVEL GAGE.—Bulletin No. 69, published by the Bristol Co., Waterbury, Conn., describes an improved water level gage, which automatically registers the height of water in rivers, reservoirs, etc., and this recorder has also been developed for registering the depth or volume of oil, in fuel oil or storage tanks.

THE MOVEMENT OF MARKETS.—Dodge & Day, Engineers, Drexel building, Philadelphia, have issued a four-page pamphlet, which graphically shows the movement of stock values as represented by weekly average prices of 20 active railroad stocks. Another chart indicates that materials and money markets follow any sharp decline in the price of stocks. The information contained in the pamphlet is interesting especially in view of present business conditions.

GENERAL INDUSTRIAL NOTES

The capital stock of the Flour City Ornamental Iron Works, Minneapolis, has been increased to $250,000. William Burns has been elected vice president and director of this concern.

The Enterprise Foundry Co., Piqua, O., has purchased the plant of the Troy Foundry & Machine Co., Troy, O. Soil pipe molding machines are now being installed as well as other modern equipment. W. J. Smith, proprietor of the plant, has had a wide experience in soil pipe manufacture and is preparing to increase the production of his recently acquired plant. The Troy foundry is equipped with a 60-ton cupola and a 25-ton traveling crane and is provided with a well-arranged machine shop. The firm name will be changed to the Enterprise Foundry of Troy, Ohio.

The company that is being organized by R. L. Beasley, Gordon, Ala., will be known by the name of the United States Steam Stump-Pulling & Mfg. Co. The plant will consist of steel and gray iron foundries, and hoisting engine machinery and stump-pullers will be built. The main building of the plant will be 75 x 500 feet. Each foundry will have a capacity of one ton daily.

The National Steel Castings Co., of Guthrie, Okla., and Chicago, has been granted a charter, with a capital of $400,000. The incorporators are William C. Payne, Roy E. Bird and H. W. Pentecost.

The Monitor Sad Iron Co, Big Prairie, O., has been incorporated with a capital of $50,000 by J. C. Lake, E. R. Critchfield, B. A. Lake, Harvey Emmons, and A. V. Rush.

Henry H. Hoffman, Max R. Hoffman and Fannie H. Hoffman have organized the Superior Stove Works, 115 Dearborn street, Chicago, with a capital of $10,000, to manufacture stoves and castings.

The Monarch Foundry Co., Stockton, Cal., is now occupying its new plant which was recently completed. The plant includes a foundry 65 x 98 feet, a two-story pattern shop and storage room and other buildings.

The Schreiber & Conchar Mfg. Co., Dubuque, Ia., has changed its name to the Loetscher-Ryan Mfg. Co. The company will continue the manufacture of sad irons, registers and hardware specialties under the same management as in the past.

A syndicate headed by Jesse G. Yeager, president of the Yeager Hunter Stove Works, has purchased the large idle stove plant at Royersford, Pa., and will put it in operation at once. The purchasing company has organized by electing E. L. Garber, president; Frederick Schoff, vice president; and M. B. Leeman, secretary and treasurer.

Harry T. Hance and associates have equipped the old Westerville foundry, Westerville, O., with the machinery from the Hance foundry in Plain City, have added a new 8-ton cupola and other improvements, and are now ready to operate the plant.

The Allegheny Valley Malleable Iron Co., New Kensington, Pa., expects to place its new plant in operation within a short time. This plant has a melting capacity of 100 tons per day and a floor capacity for handling 60 to 80 tons, which will be the estimated output.

The Louisville Car Wheel & Railway Co., Louisville, Ky., expects to begin operating its new plant about April 1. The building is of concrete and steel and has been equipped throughout with the most modern machinery. The new plant will have a capacity of 350 to 400 wheels per day, while its old plant can produce but 150 wheels per day. The officers are: Pinckney E. Green, president and treasurer; James O. Green, vice president; G. H. Cheney, superintendent.

The new plant of the Modern Foundry Co., Oakley, Cincinnati, which has been erected to supply castings for the Cincinnati Milling Machine Co., and manufacturers of similar lines, has been placed in operation. The development of this plant has awakened a great deal of interest, as the latest improvements known in foundry practice have been incorporated in its construction and equipment.

Under the name of the Milton Foundry Co., a foundry plant at Milton, N. Y., which has been idle for a number of years, has resumed operations. The company is backed by Henry Reischmann and will furnish castings for the table manufacturing firm of M. Reischmann & Sons, New York City.

New Construction.

The Nampa Iron Works, Ltd., Nampa, Idaho, is erecting a plant for general foundry work. A building 35 x 100 feet is now under construction for a pattern shop and a brick foundry, 35 x 55 feet will also be erected. A machine shop will be added later.

F. A. Klaine & Co., Cincinnati, have purchased an adjoining lot, 50 x 80 feet, on Front street, on which they plan to erect an addition to their foundry.

The Strong Steel Foundry Co., Buffalo, N. Y., has been incorporated with a capital of $50,000, for the manufacture of open-hearth steel castings, also manganese, vanadium, chrome and other special steels to meet the technical requirements of different purchasers. The buildings formerly used by the Buffalo Cement Co. at Main and Amherst streets, with railroad switches, have been secured and will be equipped for the production of 400 tons per month. The following officers and directors have been elected: E. M. Hagar, president; Alfred A. Berrick, vice president; O. H. P. Champlin, secretary and treasurer; E. C. Strong, general manager, and Alvin W. Day. Mr. Strong has been in the steel business for 18 years and has been responsible for the entire output of one of the largest and most successful steel casting plants in the country.

The Phoenix Foundry & Machine Co., Springfield, Mo., is planning to erect a new foundry, 50 x 87 feet, which it expects to have in operation about May 1. The equipment has already been purchased.

The Campbell Mfg. Co., Gadsden, Ala., has been incorporated with a capital stock of $50,000, $35,000 of which has been paid in, and will at once erect a foundry for the manufacture of plumbers' supplies. Otto Agricola, of Gadsden, is president, and R. W. Campbell, formerly manager of the Coosa Pipe & Foundry Co.'s plant, vice president and general manager.

The Price-Evans Foundry Co., Chattanooga, Tenn., is planning a steel and brick addition, 60 x 110 feet, to its present plant for the manufacture of architectural iron work and foundry specialties. Its erection will depend on the closing of a street at the end of the company's property.

The blacksmith shop and foundry which the Delaware, Lackawanna & Western Railroad is now erecting at Scranton, Pa., will be completed some time in the fall and considerable new equipment will be required. The blacksmith shop is 125 x 300 feet and the foundry 120 x 400 feet. The extensive machine shops of the same plant will probably not be ready for operation within two years.

The Olympic Foundry Co., Tacoma, Wash., is erecting a foundry, 50 x 80 feet; pattern shop, 50 x 55 feet; and machine shop, 50 x 55 feet. The foundry equipment will include one 5-ton and one 20-ton cupola, and a 15-ton electric traveling crane.

Frank Marty, Meridian, Miss., is building a new foundry, 32 x 70 feet. He will do gray iron work at first, but expects later to take up brass casting and general machine work and will be glad to consider the manufacture of some marketable machine or foundry specialty.

The Salina Foundry & Mfg. Co., Salina, Kas., has decided to enlarge its plant and purchase some additional machinery.

The Business Men's Association of Pueblo, Colo., has made arrangements for the removal of the stove works of the Collins & Burgie Co. from Marengo, Ill. to Pueblo. A bonus of $15,000 was given with the understanding that work on the Pueblo plant, which will cost $150,000, will be begun within 60 days from Feb. 1.

Brass Foundries.

The Bushing Faucet & Valve Co., Brooklyn, N. Y., has been incorporated with $100,000 capital. The directors include George Bibby, 677 Atlantic avenue, John McNeely, 768 Bergen street, and Marvin Hudson, 99 South Elliott place.

Meneely & Co, Watervliet, N. Y., have been organized with a capital of $50,000 to manufacture bells, chimes, etc. Those interested are A. E. Meneely, G. Y. Meneely and E. A. Meneely.

The Meriden Iron & Brass Co., Meriden, Conn., has been organized with a capital stock of $10,000. George Knouth is president and secretary and Frederick Radke, treasurer.

The Milwaukee Ornamental Metallic Mfg. Co., 216 Lake street, Milwaukee, has changed its name to the Milwaukee Bronze Casting Co., and has increased its capital stock from $1,000 to $10,000. A new foundry will be built to provide for its rapidly growing business. Albert G. Seeboth is president; M. Seeboth, secretary and treasurer; and Casper Reichl, general manager.

Reports showing the most prosperous year in the history of the company were made at the annual meeting of the Falcon Bronze Co., Youngstown, O. The following officers and directors were re-elected: President and general manager, G. A. Doeright; vice president, Thomas Parrock; secretary, Joseph G. Haney; treasurer, E. E. Miller, and C. H. Kennedy, director.

The American Bell & Foundry Co., Northville, Mich., at its recent annual meeting, re-elected its old officers and increased its capital stock to $32,000.

A petition for the dissolution of the copartnership known as the Brown Iron & Brass Works, of Ogden, Neb., has been filed by President A. W. Brown and other stockholders.

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ADVERTISERS

Adams Co. 22, 139
Addy, Matthew & Co. 151
Ajax Metal Co. 143
Albany & North River Molding Sand Co. 147
American Air Compressor Works. 136
American Blower Co. 44
American Wire Brush Co. 112
Arcade Mfg. Co. 21
Atlas Car & Mfg. Co. 133

Baird & West. 151
Barnett, Oscar, Foundry Co. 24
Bassite Mining & Smelting Co. 36
Berkshire Mfg. Co. 20
Blackwell, Geo. G., Sons & Co. 143
*Blake, Geo. F., Mfg. Co. 140
Borgner, Cyrus, Co. 148
Box & Co., Alfred. 124
Brass Founders' Supply Co. 138
Bridgeport Safety Emery Wheel Co. 147
Bristol Co. 144
Brown Hoisting Machinery Co. 123
Brown Specialty Machinery Co. 26
Burdick & Son. 135
*Byram & Co. 130

Carborundum Co. 117
Carr & Speer. 147
Case Mfg. Co. 124
Central Foundry Supply Co. 132
Clark Cast Steel Cement Co. 31
Cleveland Crane & Car Co. 125
Cleveland Fillet Co. 148
Columbus Iron & Steel Co. 150
Connersville Blower Co. .....Back cover
Cornell, J. B. & J. M., Co. 136
Crivel & Co., George F. 132
Curtis & Co. Mfg. Co. 127

*Deane Steam Pump Co. .....—
Debevoise-Anderson Co. 151
DeCamp Bros. & Yule Iron, Coal & Coke Co. 151
Detroit Foundry Supply Co. 115
Diamond Clamp & Flask Co. 141
Dimmick, J. K., & Co. 151
Dings Electro Magnetic Separator Co. 142
Dixon, Joseph, Crucible Co. 49
Dobson, William 121
Dodge & Day. 146
Doggett, Stanley 136
Domhoff & Joyce Co. 150
Drucklieb, C. 117

Elm City Engineering Co. 142
Engineers' & Founders Laboratories. 146
Etting, Edward J. 131

Falls Rivet & Machine Co. 10
Field, Alfred, & Co. 140
Field, Robt., Sales Agency. 150

Foundry Specialty Co. 134
Fox Machine Co. 135

Gautier, J. H., & Co. 52, 148
General Pneumatic Tool Co. 125
Gilmour, J. 133
Goldschmidt Thermit Co. 135
Goodrich, F. A., & Co. 151

*Harbison-Walker Refractories Co. .....—
Harrington, Edward, Sons & Co. 126
Hawley Down Draft Furnace Co. 40
Herman Pneumatic Machine Co. 23
Hill & Griffith Co. 8
Hillman, J. H., & Son. 150
Hoist Co., The. 126

Jones & Attwood. 140

Keep, W. J. 146
Kerr Turbine Co. 136
*Kessler & Weidemann .....—
Killing Molding Machine Co. 19
Knickerbocker Co. 119

Laclede-Christy Clay Products Co. 148
Lindsay, W. W., & Co. 118
Link-Belt Co. 128

Manning, Maxwell & Moore. 123
Maris Bros. 124
Maurer, Henry, & Son. 148
McCormick, J. S., Co. 32
McCullough-Dalzell Crucible Co. 48
McKeefrey & Co. 150
Metallic Alloys Co. 144
Metallurgical Laboratory 144
Midvale Mining & Mfg. Co. 145
Millet Core Oven Co. 28
Mitchell-Parks Mfg. Co. 25
Mohr, J. J., & Son. 150
Monarch Emery & Corundum Wheel Co. . 119
Monarch Engineering & Mfg. Co. 41
Moyer Tramrail Co. 129
Mumford, E. H., & Co. 16, 17, 18

Nash, Isham & Co. 151
New England Eng. & Equipment Co. 126
New Era Mfg. Co. 144
Newport Sand Bank Co. 147
Niles-Bement-Pond Co. 122
Northern Engineering Works 122, 131
Norton Co. 119
Norwalk Iron Works Co. 137

Obermayer, S., Co. 2, 3
Osborn Mfg. Co. 153
Otis Steel Co. 147

Paige Retort & Crucible Co. 130
Pangborn Co., Thomas W. 9

Pattern Letter Co. 148
Pawling & Harnischfeger. 125
Paxson, J. W., Co. 4, 5, 6
Peninsular Tool & Specialty Co. 121
*Penn, Wm., Silica Works. .....—
*Pettinos Bros. 34
Philadelphia Tramrail Co. 128
Phosphor Bronze Smelting Co. 144
Pickands, Brown & Co. 151
Pickands, Mather & Co. 150
Pilling & Crane. 150
Piqua Blower Co. 53
Pridmore, Henry E. 12, 13

Rathbone, John A. 16
Rendle, Arthur E. 118
Ridgway, Craig, & Son Co. 46
Roberts Portable Oven Co. 141
Robeson Process Co. 27
Rockwell Engineering Co. 132
Roessler & Hasslacher Chemical Co. 143, 145
Rogers, Brown & Co. 151, 152
Roots, P. H., & F. M., Co. .....Insert
Ross-Tacony Crucible Co. 51

Samuel, Frank 150
Seaver, John W. 146
Seidel, R. B., Inc. 131
Sellers, Wm., & Co. 39
Shanafelt Mfg. Co. 33
Shelton Metallic Filler Co. 29
Shepard, Chas. G. 151
Shuster, F. B., Co. 142
Sly, W. W., Mfg. Co. 38
Smith, J. D., Foundry Supply Co. 11
Smooth-On Mfg. Co. 30
Swoboda, L. J. 137
Standard Sand & Machine Co. 138
Sterling Oil Co. 140
Stevens, F. B. 35, 113, 148
Stockham Mfg. Co. 138
Stow Mfg. Co. 117
Stradley & Co., Edward M. 121
Sturtevant, B. F., Co. 43
Superior Charcoal Iron Co. 151

Tabor Mfg. Co. 14, 15
Taylor, A. L. 148
Taylor, Robt. Jr., Inc. 50
Thomas Furnace Co. 151
Tilghman-Brooksbank Sand Blast Co. 37
Toledo Mfg. Co. 47
Turner Machine Co. 139

U. S. Chaplet Supply Co. 139
United Iron & Steel Co. 149
United States Graphite Co. 134

*Waldie & McCauley Sand Co. .....—
Walter-Wallingford & Co. 150
Western Foundry Supply Co. 145
Whitehead Bros. Co. 7
Whiting Foundry Equipment Co. 54, 111
Wilbraham-Green Blower Co. 45

Yale & Towne Mfg. Co. 126

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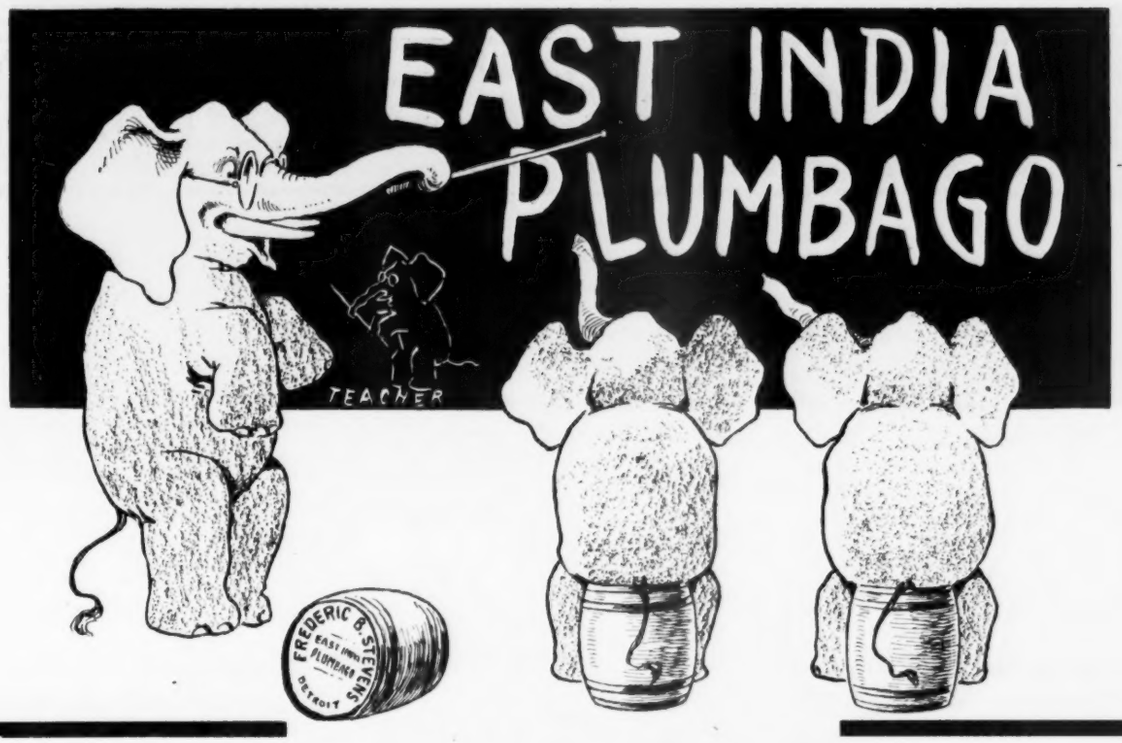

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See page 35

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Norton Company, Worcester, Mass.

Accountants:

Stradley & Co., Edward M., Philadelphia.

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American Air Compressor Works, New York.
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Norwalk Iron Works Co., So. Norwalk, Conn.

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New Era Mfg. Co., Kalamazoo, Mich.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

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Keep, W. J., Detroit.

Analysis—Chemical:

Engineers & Founders Laboratories, Pittsburg.
Kessler & Wiedemann, St. Louis, Mo.
Metallurgical Laboratory, Pittsburg.

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Ajax Metal Co., Birmingham, Ala.
Phosphor-Bronze Smelting Co., Ltd., Philadelphia, Pa.

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Connersville Blower Co., Connersville, Ind.
Cornell, J. B. & J. M. Co., New York.
Monarch Engineering & Mfg. Co., Baltimore.
Paxson, J. W. Co., Philadelphia.
Piqua Blower Co., Piqua, Ohio.
Roots, P. H. & F. M. Company, Connersville, Ind.
Sturtevant, B. F., Co., HydePark,Mass.

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Connersville Blower Co., Connersville, Ind.
Piqua Blower Co., Piqua, Ohio.
Roots, P. H. & F. M. Company, Connersville, Ind.
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Midvale Mining & Mfg. Co., E. St. Louis, Ill.

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Phosphor-Bronze Smelting Co., Ltd., Philadelphia, Pa.

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Otis Steel Co., Ltd., Cleveland.

Cement (Furnace):

Gautier, J. H. & Co., Jersey City.

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Clark Cast Steel Cement Co., Shelton, Conn.
Shanafelt Mfg. Co., Canton, O.
Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City.

Chaplets:

Burdick & Son, Albany, N. Y.
Lindsay, W. W. & Co., Philadelphia.
Shanafelt Mfg. Co., Canton, O.
United States Chaplet & Supply Co., New York.

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Toledo Mfg. Co. Toledo, O.

Clay.

Haedrich, E. M., Philadelphia, Pa.

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Dimmick, J. K., & Co., Philadelphia.
Debevoise-Anderson Co., New York.
Hillman, J. H. & Son, Pittsburg.
Rogers, Brown & Co., Cincinnati.

Conveyors:

Link-Belt Co., Philadelphia, Pa.

Cores:

Brown Specialty Machry. Co., Chicago.

Core Binders:

Robeson Process Co., Au Sable Forks, N. Y.
Sterling Oil Co., Emlenton, Pa.

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Brown Specialty Machry. Co., Chicago.
Falls Rivet & Mch. Co., Cuyahoga Falls, O.
Jones & Atwood, Stourbridge, Eng.

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Atlas Car & Mfg. Co., Cleveland.
Falls Rivet & Mch. Co., Cuyahoga Falls, O.
Hill & Griffith Co., Cincinnati.
Millett Core Oven Co., Brightwood, Mass.
Pangborn Company, Thomas W. New York.
Paxson, J. W. Co., Philadelphia.
Roberts Portable Oven Co, Chicago.
Smith, J D., Foundry Supply Co., Cleveland.

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Bristol Co., Waterbury.

Core Tapering Machines:

Brown Specialty Machry. Co., Chicago.

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Monarch Emery & Corundum Wheel Co., Camden, N. J.

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Cleveland Crane & Car Co., Wickliffe, O.
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Manning, Maxwell & Moore, New York.
Maris Bros., Philadelphia.
Niles-Bement-Pond Co., New York.
Northern Engrng. Works, Detroit.
Ridgway, Craig & Son, Coatesville, Pa.
Sellers, William & Co., Inc., Philadelphia.
Whiting Foundry & Equipment Co., Harvey, Ill.

Crucibles:

Brass Founders Supply Co., Newark, N. J.
Dixon Crucible Co., Jos., Jersey City.
Gautier, J. H. & Co., Jersey City.
McCullough-Dalzell Crucible Co., Pittsburg.
Monarch Engineering & Mfg. Co., Baltimore.
Paige Retort & Crucible Co., Taunton, Mass.
Paxson, J. W. Co., Philadelphia.
Ross-Tacony Crucible Co., Philadelphia.
Seidel, R. B., Inc., Philadelphia, Pa.
Taylor, A. L., San Francisco.
Taylor, Robt. J., Inc., Philadelphia.

Cupolas:

Byram & Co., Detroit.
Detroit Foundry Supply Co., Detroit.
Etting, Edward J., Philadelphia.
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Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City.

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Maurer, Henry, & Son, New York.
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Wm. Penn., Silica Works, Wm. Penn, P. O., Philadelphia.

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Brass Founders' Supply Co., Newark.
Killing Molding Machine Co., Davenport, Ia.

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Paxson, J. W. Co., Philadelphia.

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Obermayer, S. Co., Cincinnati.
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Sly, W. W. Mfg. Co., Cleveland.
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Stevens, F. B., Detroit.
Taylor, Robert J., Inc., Philadelphia.

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Crivel & Co., Geo. F., Buffalo.
Detroit Foundry Supply Co., Detroit.
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McCormick, J. S. Co., Pittsburg.
Obermayer, S. Co., Cincinnati.
Osborn Mfg. Co., Cleveland.
Pangborn Company, Thomas W. New York.
Paxson, J. W. Co., Philadelphia.
Smith, J. D., Foundry Supply Co., Cleveland.
Stevens, F. B., Detroit.
Taylor, A. L., San Francisco.
Taylor, Robert J., Inc., Philadelphia.
United States Graphite Co., Saginaw, Mich.
Whitehead Bros. Co., New York, Providence, Buffalo.

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Brass Founders Supply Co., Newark, N. J.
Hawley Down Draft Furnace Co., Chicago.
Monarch Engineering & Mfg. Co., Baltimore.
Paxson, J. W. Co., Philadelphia.
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Yale & Towne Mfg. Co., New York.

Hoists (Hand):

Northern Engrng. Works, Detroit.

Hoists (Pneumatic):

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Ridgway, Craig, & Son, Coatesville, Pa.

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Atlas Car & Mfg. Co., Cleveland.

Iron Ore:

Rogers, Brown & Co., Cincinnati.

Lead (Black):

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Molding Machines:

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Herman Pneumatic Machine Co., Zelienople, Pa.
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Paxson, J. W. Co., Philadelphia.
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Smith, J. D., Foundry Supply Co., Cleveland.
Tabor Mfg. Co., Philadelphia.

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Gautier, J. H., & Co., Jersey City.
Hill & Griffith Co., Cincinnati.
McCormick Co., J. S., Pittsburg.
McCullough-Dalzell Crucible Co., Pittsburg.
Obermayer, S. Co., Cincinnati.
Pettinos Bros., Bethlehem, Pa.
Ross-Tacony Crucible Co., Philadelphia.
Smith, J. D., Foundry Supply Co., Cleveland.
Stevens, F. B., Detroit.
United States Graphite Co., Saginaw, Mich.
Whitehead Bros. Co., New York, Providence, Buffalo.

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Stevens, F. B., Detroit.
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Whitehead Bros. Co., New York, Providence, Buffalo.

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Standard Sand & Machine Co., Cleveland.
U. S. Chaplet Supply Co., New York.

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Turner Machine Co., Philadelphia.

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Ross-Tacony Crucible Co., Philadelphia.
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Keep, W. J., Detroit.

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Paxson, J. W. Co., Philadelphia.
Peninsular Tool & Specialty Co., Detroit, Mich.

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Philadelphia Tramrail Co., Philadelphia.

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Philadelphia Tram-Rail Co. Philadelphia, Pa.

Tumbling Mills:

Adams Co., Dubuque, Ia.
Falls Rivet & Mch. Co., Cuyahoga Falls, O.
Gilmour, J., New York.
Sly, W. W., Mfg. Co., Cleveland.

Turbines:

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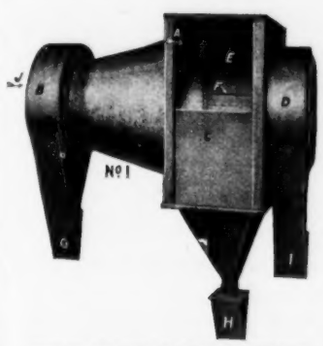
68



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FIRST CLASS MOLDER WANTED WHO will take stock in stock company just organizing in Black Hills, old established business. Address J. C. O'Donnell, Deadwood, S. D.

GRAY IRON FOUNDRY MOLDERS wanted. Highest wages paid. St. Louis Car Wheel Company, St. Louis, Mo.

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POSITION AS SUPERINTENDENT OR foreman wanted, in Foundry. Am 44 years of age, have had 20 years' experience in charge of Foundry producing high-grade heavy, medium and light castings with an output of 80 tons per day. Can introduce latest methods in green loam and dry sand. Well up in cupola practice and mixtures of metals. Will furnish references. Address Box 615, THE FOUNDRY, Cleveland, Ohio.

POSITION WANTED AS FOUNDRY SUperintendent or foreman, by man who is fully competent to take entire charge of foundry making any class of work up to five tons, also mixing iron from analysis. Address Box 737, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS SUPERINTENDent or manager of foundry engaged in the manufacture of chilled iron car wheels. Ten years' experience with leading concern of country. Practical knowledge of every detail including cupola practice and mixing of metals. Good executive ability and up-to-date in all methods. Married and strictly temperate. Best of references from present and past employers. Address Box 734, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS SUPERINTENDent or foreman by a practical foundryman on heavy and light gray iron castings. Well experienced on cupola and molding machines. Will furnish A-1 references. Address Box 740, THE FOUNDRY, Cleveland, O.

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POSITION WANTED BY AN A-1 FOUNdry foreman by May 1, at present employed by one of the leading engineering companies of the east. Thoroughly understands the workings of loam, dry and green sand. Also thoroughly understands cupola practice and mixture of iron by chemical analysis. 36 years of age, am married and of good moral habits. Address Box 743, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOUNDRY foreman, 13 years' Malleable foundry practice, also had large experience handling foundry laborers at minimum cost. Address Box 751, THE FOUNDRY, Cleveland, Ohio.

POSITION WANTED AS FOUNDRY foreman in a first-class foundry. One that understands steam boilers and radiator, general jobbing and a first class rigger. Address Box 703, THE FOUNDRY, Cleveland, O.

POSITION WANTED BY FOUNDRY foreman, practical man, on all kinds of water works equipment, special castings, valves, hydrants, and general gray iron castings, well qualified to handle men. Address Box 738, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOUNDRY foreman by a sober, reliable, energetic young married man who is not afraid of work. Address W. A. S., 521 Park Bldg., Pittsburg, Pa.

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POSITION WANTED BY JOBBING brass molder willing to go to any part of the United States. Can handle any kind of metal, old or new, heavy or light castings. Am a strictly sober and steady worker. Address Box 749, THE FOUNDRY, Cleveland, O.

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POSITION WANTED BY EXPERIENCED side blow converter blower, with technical education, practical molder and foundry chemist. Address Box 745, THE FOUNDRY, Cleveland, O.

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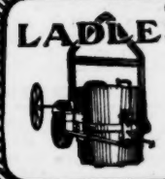
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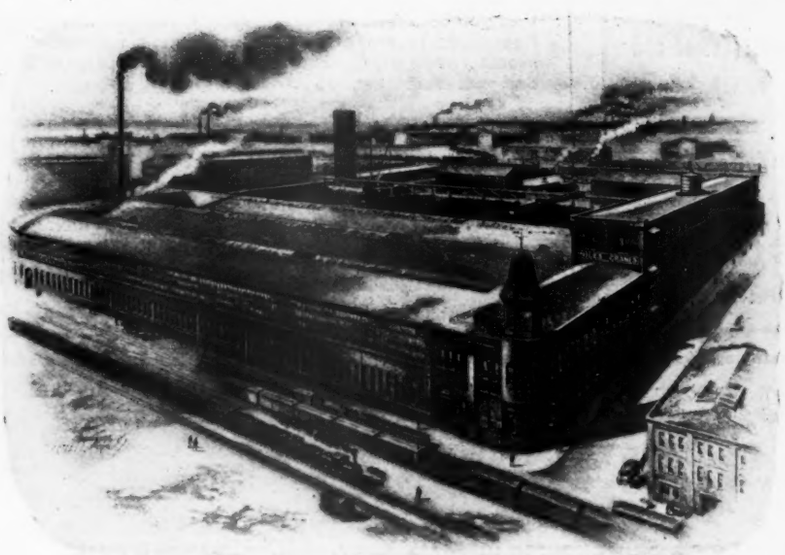

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